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The Office of Policy Analysis within EPA has been conducting a study of the ecological risks posed by Superfund Sites and RCRA Facilities. In June 1989, OPA completed the first phase of this study and this report presents the results of OPA's efforts to characterize the nature and extent of ecological risks at Superfund sites and RCRA facilities. The report is divided into two main parts: Part I addresses Superfund sites and Part II addresses RCRA facilities.

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THE NATURE AND EXTENT OF ECOLOGICAL RISKS AT SUPERFUND SITES AND RCRA FACILITIES

Office of Policy Analysis
Office of Policy, Planning, and Evaluation
U.S. Environmental Protection Agency
Washington, D.C.

June 1989

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EXECUTIVE SUMMARY

The Office of Policy Analysis (OPA) within the U.S. Environmental Protection Agency (EPA) Office of Policy, Planning, and Evaluation has been conducting a study of the ecological risks posed by Superfund sites and RCRA facilities. In June 1989, OPA completed the first phase of this study and published the following four reports that document the study's findings:

- "The Nature and Extent of Ecological Risks at Superfund Sites and RCRA Facilities," EPA-230-03-89-043 (June 1989).
- "Ecological Risk Assessment Methods: a Review and Evaluation of Past Practices in the Superfund and RCRA Programs," EPA-230-03-89-044 (June 1989).
- "Ecological Risk Management in the Superfund and RCRA Programs," EPA-230-03-89-045 (June 1989).
- "Summary of Ecological Risks, Assessment Methods, and Risk Management Decisions in Superfund and RCRA," EPA-230-03-89-046 (June 1989).

This report presents the results of OPA's effort to characterize the nature and extent of ecological risks at Superfund sites and RCRA facilities. The report is divided into two main parts; Part I addresses Superfund sites and Part II addresses RCRA facilities. Key findings from both of these parts are summarized below.

I. SUPERFUND SITES

In this part of the study, Superfund sites with observed or projected ecological threats were identified through a telephone survey and literature review. Data on the nature and extent of ecological threats at a sample of 52 National Priorities List (NPL) sites were then extracted from available site reports.

Roughly 90 percent of the sites reviewed are threatening fresh water ecosystems. Threats to terrestrial ecosystems have been observed or projected at slightly less than 50 percent of the sites. Soil, ground water, surface water, and surface water sediments were all frequently observed to be contaminated at the sample sites. Fish or aquatic invertebrates were observed or projected to be contaminated at approximately 70 percent of the sample sites, with these organisms displaying a variety of toxic effects. When noted, adverse terrestrial effects took the form of damaged or killed vegetation, loss of habitat, contamination or loss of food sources, and in a few cases, projected toxic effects to birds and mammals.

This study's data suggest that the extent of threats varies widely across Superfund sites, both in terms of the area affected and magnitude of impact. From a relative standpoint, 10 percent of the sample sites present particularly severe ecological threats, characterized by high levels of environmental contamination spread over relatively large areas with large ecological populations that are (or could be) exposed. Another 10 percent present relatively minor threats, characterized by low levels of environmental contamination confined to small areas and relatively small numbers of potential ecological receptors. Therefore, 80 percent of the sample sites pose relatively moderate threats, characterized by potential acute threats in small areas and possible chronic or low-level threats spread over larger areas.

A wide variety of waste types, waste management practices, and environmental settings is represented in the sample. However, the most common scenario involves municipal/commercial/industrial waste commingled in a landfill close to a surface water body or wetland. Almost 40 percent of the sites were noted have surface water onsite, most commonly drainage ditches or small creeks that appear to act as conduits for waste constituent migration, as well as habitat for aquatic receptors. The most frequently encountered contaminants in the sample are lead, cadmium, arsenic, chromium, zinc, VOCs, PCBs, and PAHs.

While the 52 sample sites studied in this analysis may not be statistically representative of all Superfund sites, they are illustrative of the various kinds of sites on the NPL. Firm conclusions about the overall extent and significance of ecological threats at Superfund sites cannot be drawn because of a lack of detailed ecological data (especially data on the extent of ecological threats), a lack of ecological toxicity reference levels, scientific uncertainties about the response of ecosystems to chemical contamination, and a lack of Superfund policy on what constitutes a "significant" effect. However, generalizations about the significance of these effects include the following observations:

- Almost all of the sites in the sample have contaminants present that are acutely toxic to aquatic organisms when present in sufficient concentrations; however, in the sample studied, very intense (or acute) effects were observed or projected at only a small fraction of the sites or appeared to be limited to small areas;

- Contaminants present at most of the sample sites are persistent and bioaccumulative, and thus may present long-term ecological threats if not cleaned up;

- Slightly more than half of the sample sites appear to be threatening unique, vulnerable, commercially important, or recreationally important resources; and

- The threats at individual sites must be considered in the context of the large number of Superfund sites in order to assess the aggregate national extent of ecological threat. Based on this study's data, a very rough, preliminary estimate is that as many as a third of all Superfund sites have the potential for significant ecological threats.

II. RCRA FACILITIES

OPA analyzed the nature and extent of ecological threats at RCRA facilities through an investigation of six RCRA program areas: Subtitle C, Subtitle D, mining, coal utilities, oil and gas, and smelting and refining. OPA conducted the analysis of the extent of the ecological threats at these facilities by investigating a number of Regulatory Impact Analyses and other broad regulatory and policy analyses previously conducted by the Office of Solid Waste and the EPA Regional offices. OPA's examination of the nature of these threats included a review of these OSW studies and was further enhanced through the development and analysis of damage case studies developed for each RCRA program area.

Extent

The extent of ecological threats at RCRA facilities has been generally described in Regulatory Impact Analyses, Reports to Congress, Background Documents, and special reports prepared by OSW and the Regions. Although few of these sources investigate the extent of ecological impacts in great detail, they do provide some indication of the problem. OSW estimates that 17 percent of all Subtitle C TSDFs will require surface water cleanup, 34 percent will require soil cleanup, 30 percent will require ground-water cleanup, and seven percent of the facilities will require air cleanup. Roughly 11 million barrels of oil and gas drilling wastes are released annually from over 9,000 spills. In addition, an estimated 26 percent of the active mining and 32 percent of the coal utility facilities are within five kilometers of sensitive environmental areas. Seventy-eight percent of the phosphate mines sampled were within five kilometers of wetlands, and 60 percent of mining waste management case studies reported effects on non-human biota. Although little is presently known concerning the characteristics of ecological damage resulting from these releases, waste management activities conducted under all of these RCRA program areas appear to pose a substantial potential threat to the environment.

Nature

The precise nature of the ecological threats at RCRA facilities is not well understood, but OPA identified and analyzed a number of examples of observed and predicted ecological damages at RCRA facilities. Exhibit ES-1 presents a summary, prepared by OPA, of the observed ecological threat characteristics of each RCRA program area in terms of the observed ecological damages, waste management practices, environmental settings, and principal waste types. Based on these examples, OPA summarizes the nature of ecological threats posed by RCRA facilities as follows.

- The severity of ecological threats depends on
    - environmental setting (e.g., wetlands),

EXHIBIT ES-1

OBSERVED ECOLOGICAL THREAT CHARACTERISTICS OF RCRA PROGRAM AREAS

Program Area	Observed Ecological Damages	Waste Management Practices	Environmental Settings	Waste Types
Subtitle C	▪ Mortality - fish and vegetation kills ▪ Decreased species richness and diversity ▪ Increased body burden of toxicants ▪ Decreased productivity ▪ Altered life cycles ▪ Habitat alteration	▪ Landfills ▪ Surface impoundments (unlined) ▪ Container storage ▪ Wastewater discharge ▪ Waste piles	▪ Near surface waters ▪ Wetlands ▪ Special habitats (i.e., endangered and protected species habitat, and wildlife refuge)	▪ Metals - Cr, As, Pb, Hg ▪ Aromatic hydrocarbons and substituted aromatic compounds ▪ Solvents ▪ Other VOCs ▪ Creosote ▪ PCBs ▪ Acids ▪ Alkali ▪ Pesticides
Subtitle D	▪ Impaired overall health and fertility of freshwater and estuarine fish and macroinvertebrates ▪ Potential for contamination to all environmental media and thus widespread effects to terrestrial and aquatic species	▪ Uncontained disposal (e.g., dumping to surface waters) of combustion fly ash ▪ Storage in unlined landfills of all municipal wastes	▪ Limited available data ▪ 13 percent of facilities in 100-year floodplain ▪ 6 percent in wetland areas	▪ Particulates ▪ BOD ▪ Microbes ▪ Heavy Metals ▪ Pesticides ▪ VOCs ▪ PCDFs ▪ PCDDs
Mining	▪ Fish kills ▪ Impairment and reduction in bird, benthic and other aquatic organisms population ▪ Bioaccumulation in terrestrial organisms	▪ Tailings ponds ▪ Waste storage piles ▪ Waste hauling ▪ Surface impoundment ▪ Cyanide wash stored in drums	▪ Near surface waters	▪ Tailings, overburden, leachate solution, and mine water containing: cyanide, arsenic, copper, zinc, cadmium, lead, cobalt, silver, chromium, iron, TSS, pH
Oil and Gas	▪ Chronic and acute damages ▪ Fish kills, benthic invertebrate population reductions ▪ Reduced fertility and growth in aquatic species ▪ Vegetation damage ▪ Bioaccumulation ▪ Alteration of community structure	▪ Drilling operations ▪ Storage and disposal of drilling wastes in faulty surface impoundments ▪ Injection or discharge of process waters to ground surface	▪ Near surface waters ▪ Desert or tundra environment	▪ Drilling muds, production brines, wastewater, and oil field effluents and fracturing fluids containing: chlorides, benzene, lead, phenanthrene, barium, arsenic, fluoride, antimony
Coal-Fired Utility	▪ Fish kills ▪ Eradication of bottom-dwelling organisms and other aquatic and terrestrial plant and animal life ▪ Chronic effects also likely	▪ Improper storage or mishandling of waste sludges and fly ash wastes ▪ Illegal or improper dumping of wastes ▪ Failure of surface impoundments	▪ Limited available data ▪ Predominantly near surface water bodies	▪ Fly ash wastes containing heavy metals (aluminum, arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium and silicon)
Smelting and Refining	▪ Chronic and acute damages to aquatic organisms ▪ Surface water contaminant concentrations >400 times AWQC	▪ On-site wastewater settling ponds ▪ Cryolite sludge lagoons ▪ Storage and disposal of spent potliners	▪ Over 70 percent within 2,000 feet of surface water	▪ Spent potliners, cryolite slurries, cryolite sludges, slags, and process fluids containing: zinc, copper, cyanide, lead, cadmium and fluoride

  - facility size (i.e., quantity of wastes released),
  - toxicity characteristics of the constituents released, and
  - the nature of the release event itself (e.g., flooding, leaching to soil).

- Observed ecological damages from RCRA facility releases have been long- and short-term in nature, and include fish kills, diseased or desecrated benthic habitats, chronic or behavioral effects on aquatic and terrestrial plant and animal species, oyster mortality, reduced floral and faunal species diversity, and reduced productivity in wetland habitats.

- Evidence of potential ecological effects include increased contaminant body burdens in aquatic species, concentrations in water and soil that exceed water quality criteria or other measures of aquatic toxicity. Sparse vegetation and contaminated soils are also reported at many facilities.

- Most ecological damage was characterized in aquatic ecosystems. It is not clear whether the majority of ecological damage actually occurs in aquatic habitats, or it is simply easier and, therefore, more common to characterize impacts in this medium.

- Ecological damage was most often caused by the improper disposal or storage of wastes in unlined landfills or surface impoundments. Storage in waste piles and application of wastewaters to the land have also been noted as significant sources of damage.

- The contaminants associated with ecological damage include virtually all waste types managed at RCRA facilities. For example, the heavy metal wastes found at large volume waste facilities have been implicated in a number of damage cases.

Conclusions

This analysis of facility characteristics identified some discernible patterns concerning practices, settings, and wastes that pose the most severe ecological threats. However, it is questionable whether quantitative projections of the frequency of the characteristics can be made for the RCRA facility population as a whole based on these results. Such extrapolations are tenuous, mainly due to the limited nature of the available data characterizing the RCRA facilities and the lack of representativeness (in a statistical sense) of the sites examined. Sufficient data to accurately characterize the nature and extent of ecological impacts at RCRA facilities are generally not available. Nonetheless, this study found that many RCRA facilities have released hazardous substances into wetlands, floodplains, surface waters, or in ecologically vital or sensitive habitats, and these facilities should be considered a potential source of ecological damage. Perhaps the most significant conclusion to be drawn from this analysis is that the wide range of hazardous and non-hazardous substances managed at RCRA facilities, the numerous release and ecological exposure pathways, and the diverse nature of the observed ecological impacts indicate that releases from these facilities have the potential to affect all environmental media and major ecosystem types.

PART I: SUPERFUND SITES

CHAPTER 1

INTRODUCTION

Hazardous substances released from sites subject to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) have the potential to damage ecosystems and their components in addition to the potential to adversely affect human health. Thus far in the Superfund program, however, EPA has focused primarily on analysis and mitigation of human health risks rather than ecological risks. Limited analysis and assessment shows that ecological injury has been observed or is predicted to occur at some Superfund sites, but the overall nature and extent of ecological risks have not been thoroughly assessed.

This lack of information on ecological risks appears in part to result from a general lack of EPA policy in the areas of ecological assessment methods and ecological risk management under Superfund. To help fill this gap, OPA has conducted a study of three broad topics: (1) the nature and extent of ecological risks at Superfund sites; (2) the ecological assessment methods that have been used in the Superfund program; and (3) ecological risk management decisions and issues at Superfund sites. OPA also has studied these same topics as they pertain to the Resource Conservation and Recovery Act.[1]

The purpose of this report is to present the results of OPA's effort to characterize the nature and extent of ecological threats at Superfund sites. The report provides background information on the different types of ecological threats at a sample of 52 sites, the frequency of occurrence and magnitude of those threats, and discernible patterns in key parameters that influence ecological threats (e.g., release sources and pathways, chemical constituents, and environmental settings and receptors). These data provide background information that supplements OPA's studies of ecological assessment methods and ecological risk management issues in the Superfund program. Collectively, the results from these reports are intended to serve as the basis for conclusions on the adequacies of existing Superfund policies for ecological protection, opportunities for program improvements, and needs for further study.

This report includes data on the nature and extent of both actual, observed ecological impacts and predicted ecological impacts (i.e., risks) at Superfund sites. The term ecological "threat" often is used in the report to refer to both observed and predicted impacts. Contamination of and adverse effects to biota are examined, as is media-specific contamination that may pose a risk to biota. The report primarily focuses on baseline ecological threats that exist(ed) before response actions have been (were) taken, not the ecological problems caused by a response action or the residual threats after a response. The report's scope also is limited to an analysis of threats caused by hazardous substance releases subject to control under Superfund;

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[1] Separate reports that analyze ecological assessment methods and risk management issues in the Superfund and RCRA programs have been prepared (see the Executive Summary of this report for a full cite for these other reports).

ecological threats caused by other site operations, such as construction activities, are not covered.

An unavoidable limitation in the scope of this analysis is that all of the Superfund sites examined for ecological information are remedial sites, and primarily sites that are on the National Priorities List (NPL). Very few removal sites or non-NPL sites were examined because the analysis is based on information documented in available site reports, and limited documentation was available that describes ecological issues at these kinds of sites.

The remainder of this part of the report is divided into four chapters. Chapter 2 outlines the methods used to conduct the study. Chapter 3 presents and characterizes the sample of all Superfund sites identified as potentially posing ecological threats, including the subset of 52 sites selected for in-depth review. In Chapter 4, data on the nature and extent of ecological threats at these 52 sites are summarized and, in Chapter 5, conclusions based on the data summaries are presented.

CHAPTER 2

METHODS USED IN THIS REVIEW

The primary goals of the data collection effort undertaken in this study were to collect data for a reasonably large and diverse sample of Superfund sites, to focus on sites with recognized ecological threats, and to focus on sites where ecological threats have been studied in relative detail. Although another goal was to examine a representative sample of sites if possible, several difficulties in obtaining and studying a representative sample were encountered. These difficulties included a lack of ecological assessment documentation for non-NPL sites, an inability to obtain relevant documentation for certain NPL sites, and an insufficient base of existing ecological threat information by which to judge whether a site is "representative."

The methods used to collect and analyze data for this study involved three steps: (1) identification of candidate Superfund sites with known or suspected ecological impacts; (2) collection of relevant reports on each of the identified sites; and (3) review and analysis of the collected reports. The specific approach to each of these steps is described in the following subsections.

2.1 Identification of Sites

A telephone survey was conducted to ask people in government agencies to identify Superfund sites that have ecological threats. An initial list of primary people to call for this purpose was developed by drawing from the list of members of an interagency workgroup assembled by EPA's Office of Waste Programs Enforcement and Office of Emergency and Remedial Response to prepare the "Risk Assessment Guidance for Superfund--Environmental Evaluation Manual." Additional people to call were then identified by references from the primary contacts. In selecting prospective contacts, an effort was made to call people distributed in different areas of the U.S. and to call both EPA and non-EPA personnel, in order to gain a variety of perspectives. For example, a point was made to contact several representatives from other agencies designated as natural resource trustees under Superfund. In total, more than 50 people were contacted, including representatives of EPA Headquarters and Regions, the Department of the Interior (DOI), the National Oceanic and Atmospheric Administration (NOAA), and state Superfund offices. In some cases, follow-up meetings were held with representatives from these organizations.

In addition to the telephone contacts and meetings, Superfund sites with actual or potential ecological impacts were identified through an independent literature review. Key sources that were examined for this purpose are identified in the reference list at the end of this report.

In general, a Superfund site was added to the list of sites potentially posing ecological threats if a personal contact or a report indicated that hazardous substance releases from the site resulted in contamination of or adverse effects to biota, or resulted in significant contamination of environmental media that posed a risk to biota. Sites were not added to the list if it appeared that they mainly have ground-water contamination that is not near the land surface or discharging to the surface where it could adversely affect biota. Although no independent analysis was conducted to verify that each site identified actually poses an ecological threat, many sites were identified through multiple sources. Similarly, numerous candidate sites that were identified initially through the independent literature review were later dropped from consideration after additional information was obtained through telephone and personal contacts.

Through the process outlined above, 247 Superfund sites identified as potentially posing some level of ecological threats were identified. This sample of sites is identified in Appendix A and characterized in Section 3.1 below.

2.2 Collection of Reports

Reports describing the ecological impacts and risks at the sample of 247 sites were collected for as many sites as possible, given the time available for the project. The primary source of these reports was EPA Regional offices. The type of report that was sought in particular for each site was the remedial investigation (RI) and/or feasibility study (FS); however, separate risk/endangerment assessments, special environmental studies, and records of decision (RODs; Superfund program documents that explain the remedy selection decision for specific sites) were collected when available. Many of the sites were only in the RI/FS planning stage and, in these cases, RI/FS workplans or other planning documents that summarize the site conditions were often collected. Site-specific reports, containing varying levels of detail, were collected for a total of 103 (42 percent) of the 247 sites.

2.3 Review/Analysis of Reports

A subset of the 247 sites was selected for the purpose of extracting and compiling data on ecological threats. This subset was selected based primarily on the quantity and apparent quality of documentation collected for each site. Only those sites for which at least an RI, a detailed FS, or a detailed risk/endangerment assessment had been obtained were selected for review. Using these criteria, the reports available for 52 sites were reviewed in detail.

Relevant information was extracted in summary form from the various site reports through the use of a worksheet. The worksheet included questions to be answered by individual report reviewers in an attempt to extract consistent and complete information on the status of ecological threats at each site. After the worksheets were completed for all 52 sites, summary data were compiled using data on the individual worksheets.

There are several important caveats concerning the process used to select reports for review and the process used to extract and compile relevant data. First, as described above, the 52 sites that were examined in detail were selected primarily based on the amount and quality of information available for the sites, not because of any particular features about the sites themselves (such as geographical distribution, types of release sources, or types of wastes managed). This sample, therefore, was not intended necessarily to be representative of the full universe of Superfund sites, or even a certain category of Superfund sites. It was intentionally biased to include sites with known or suspected ecological threats and at least a moderate level of site documentation. Aspects of the "representativeness" of the sample are discussed in Section 3.2 below. Key caveats associated with the process used to extract and compile data on ecological threats include the following:

- The ecological threat information contained in the various reports was assumed to be accurate. No independent analysis of the sites was conducted to verify the accuracy of the data contained in the site reports.

- As discussed in more detail in Section 4.1, the reports reviewed varied widely in terms of the methods used to assess ecological threats and the detail in which those threats were described. This generally was true even for sites that appeared to have ecological threats of the same basic nature. As a result, the type of data and the level of detail extracted from individual reports were variable.

- Extracting data from individual site reports and then aggregating data across sites required putting the data into defined categories. For example, ecological threat data were differentiated depending on whether they were for actual vs. projected effects and whether they pertained to biota vs. environmental media. Similarly, all the different types of environments potentially affected at the sites were put into basic categories (e.g., freshwater rivers, estuaries, terrestrial) for the purpose of developing summaries. Using such categories introduces some uncertainty because it results in the data being simplified, and considerable judgment on how to categorize the data is required.

- Several of the 52 sites studied in detail have been divided into two or more operable units for the purpose of remediation. A few of the reports reviewed for those sites only address one operable unit and thus do not provide complete information on the ecological threats posed by the site as a whole. This problem was exacerbated for a small number of sites because the available reports covered operable units with little ecological impacts (it appears that operable units with primarily ecological concerns may be evaluated and remediated on a slower schedule).

- Some of the reports reviewed were not final. For 6 sites, only draft RI/FSs or draft risk/endangerment assessments were available. The ecological data extracted from these reports, therefore, are subject to change.

CHAPTER 3

CHARACTERIZATION OF SAMPLES OF SITES

As discussed in Chapter 2, a sample of 247 Superfund sites identified as potentially posing ecological threats was identified. From this sample, a subset of 52 sites was selected and analyzed for the purpose of evaluating the nature and extent of ecological threats. This chapter characterizes the sample of all sites identified (Section 3.1) and the smaller sample examined in detail (Section 3.2).

3.1 Sample of All Sites Identified as Potentially Posing Threats

The 247 sites identified as potentially posing ecological threats are listed in Appendix A. It is important to clarify that these sites do not necessarily have significant ecological impacts/risks. These are simply sites that have been identified, through the methods described in Section 2.1, as having the potential for significant ecological threats. The threats at most of these sites were not examined as part of this study, and it appears that some of the sites have been examined very little, if at all, for the purpose of characterizing ecological threats.

The 247 sites are distributed over a broad area, including 42 different states and all 10 EPA Regions. Over half of the sites are located in Regions 1, 2, and 3, with New Jersey being the state that has by far the largest number of sites.

It appears that all of the 247 sites can be categorized as remedial rather than removal sites. However, earlier emergency or removal actions have been taken at a number of the sites. Roughly 190 of the 247 sites (77 percent) are currently on the NPL; most of the others are either proposed for or recently deleted from the NPL. Of the sites that are currently on the NPL, 13 percent are within the top 50 NPL sites, 28 percent are ranked lower than number 500 on the NPL, and the remaining 59 percent are between numbers 50 and 500.

Over half of the 247 sites were identified by NOAA as potentially affecting coastal and marine resources under NOAA's trusteeship. To identify these sites, NOAA used a screening process that considers the proximity of the sites to natural resources of interest to NOAA, the toxicity and persistence of the waste constituents present, and the relative importance of resources that are potentially affected by releases (NOAA 1987). Slightly less than a third of the sites were identified through conversations with EPA Regional personnel and 13 percent of the sites were identified by representatives from DOI (both the Fish and Wildlife Service and the Office of Environmental Project Review).

There is one other characteristic of this sample that should be noted. Because of the way many of the sites were identified, it is likely that the sample is biased toward sites that have more readily apparent or sensational ecological effects. Many of the sites were identified through the recollection of individuals interviewed for this study, and it is likely that those individuals were able to recall sites with particularly noteworthy ecological problems. Similarly, other sites were identified by reviewing ROD or RI/FS summaries, and it is more likely that ecological information was documented in those summaries when the threats were relatively severe. Thus, sites with subtle effects or posing long-term threats are quite possibly under-represented in the sample.

3.2 Sample of 52 Sites Analyzed in Detail

As discussed in Section 2.3, a subset of 52 sites from the larger sample of 247 sites was selected for the purpose of characterizing the nature and extent of ecological threats. The 52 sites analyzed in detail are identified with an asterisk in Appendix A.

The geographical distribution of this sample of sites is shown in Exhibit I-1. The 52 sites are distributed over 25 states and nine EPA Regions. The only Region without a site in the sample is Region 7, which also is the Region with the fewest number of Superfund sites. The distribution of sites across the various EPA Regions is generally reflective of the distribution of Superfund sites on the NPL.

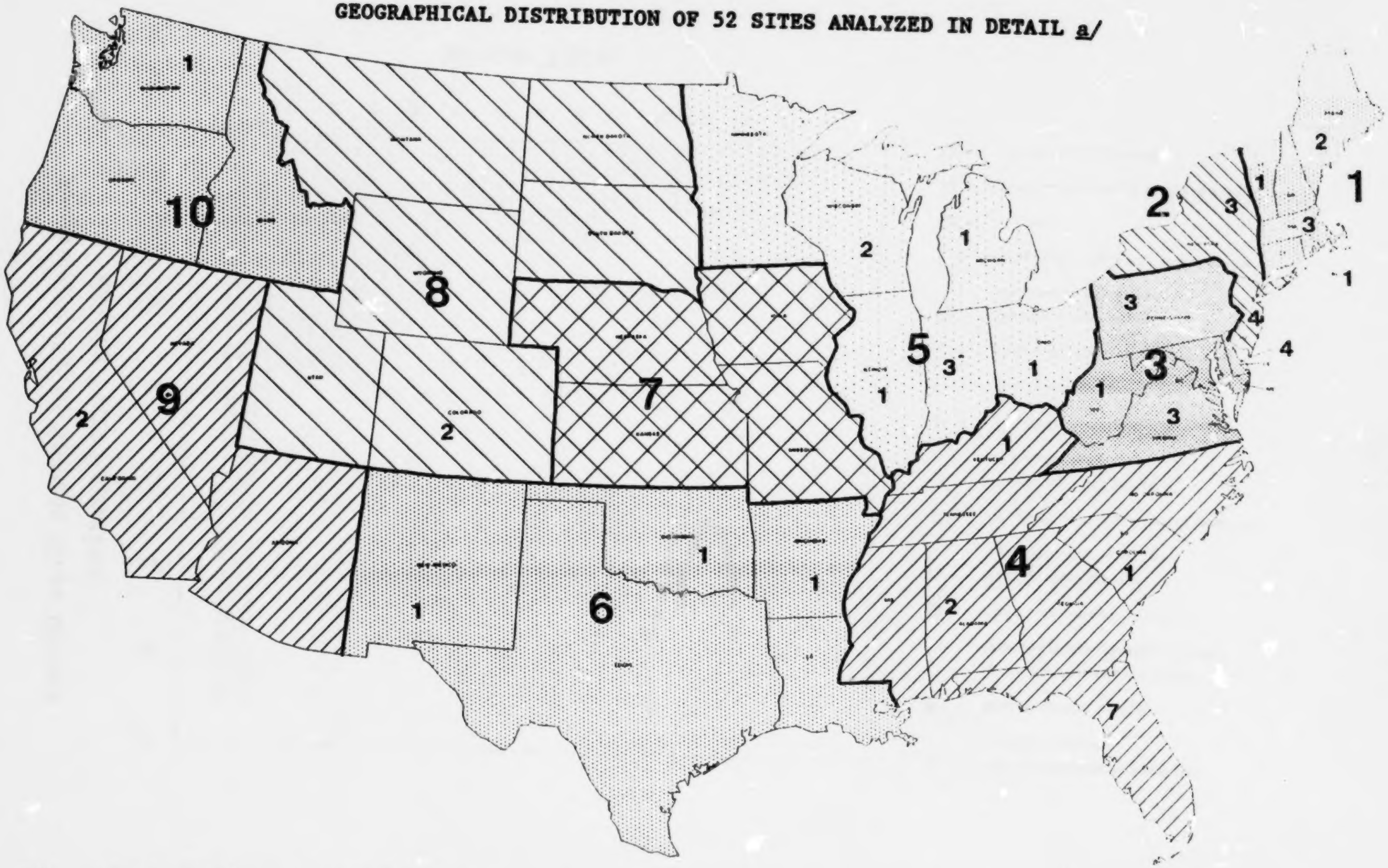
All 52 sites in the sample are categorized as remedial rather than removal sites; however, earlier removal actions have been taken at some of the sites. All but two of the 52 sites are on the NPL. Strictly in terms of numbers of sites, therefore, the sample makes up roughly 4 percent of the sites either currently on or proposed for the NPL. Of the sample sites on the NPL, roughly 70 percent are ranked higher than number 500, but only about 10 percent are ranked higher than number 50.

The frequency of occurrence of major waste types, waste management practices, and environmental settings represented by the 52-site sample is shown in Exhibits I-2 and I-3. The sites are comprised of a wide range of waste types and management practices, but the most prevalent by far are sites with mixed municipal/industrial wastes disposed in landfills. The most striking trend in terms of general environmental settings is that almost all of the sites are either directly adjacent to a surface water body or drain into a surface water body that is nearby (generally within one or two miles). More than half of the sites are also close to wetlands, swamps, or marshes.

Based on the above characterization, the sample of 52 sites analyzed for this project appears to be reasonably representative of NPL sites in general. It has a broad geographical distribution, and it is comprised of a mix of various waste types and waste management practices. Given the relative ranking of the sites on the NPL, the sample is possibly biased toward sites with generally higher priority human health threats (as ranked by Hazard Ranking System scores). Following the same rationale outlined in Section 3.1, it is also possible that the sample is comprised of sites that have relatively sensational or readily apparent ecological threats.

EXHIBIT I-1

GEOGRAPHICAL DISTRIBUTION OF 52 SITES ANALYZED IN DETAIL a/


1
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8
9
2
2
7
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2
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3
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3
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4
3
1
3
4
1
2
1
3
1
4
1
2
1
7

a/ Larger numbers denote EPA Region numbers; smaller numbers represent the number of Superfund sites analyzed in each state for this project.

EXHIBIT I-2

FREQUENCY OF WASTE TYPES IN 52-SITE SAMPLE

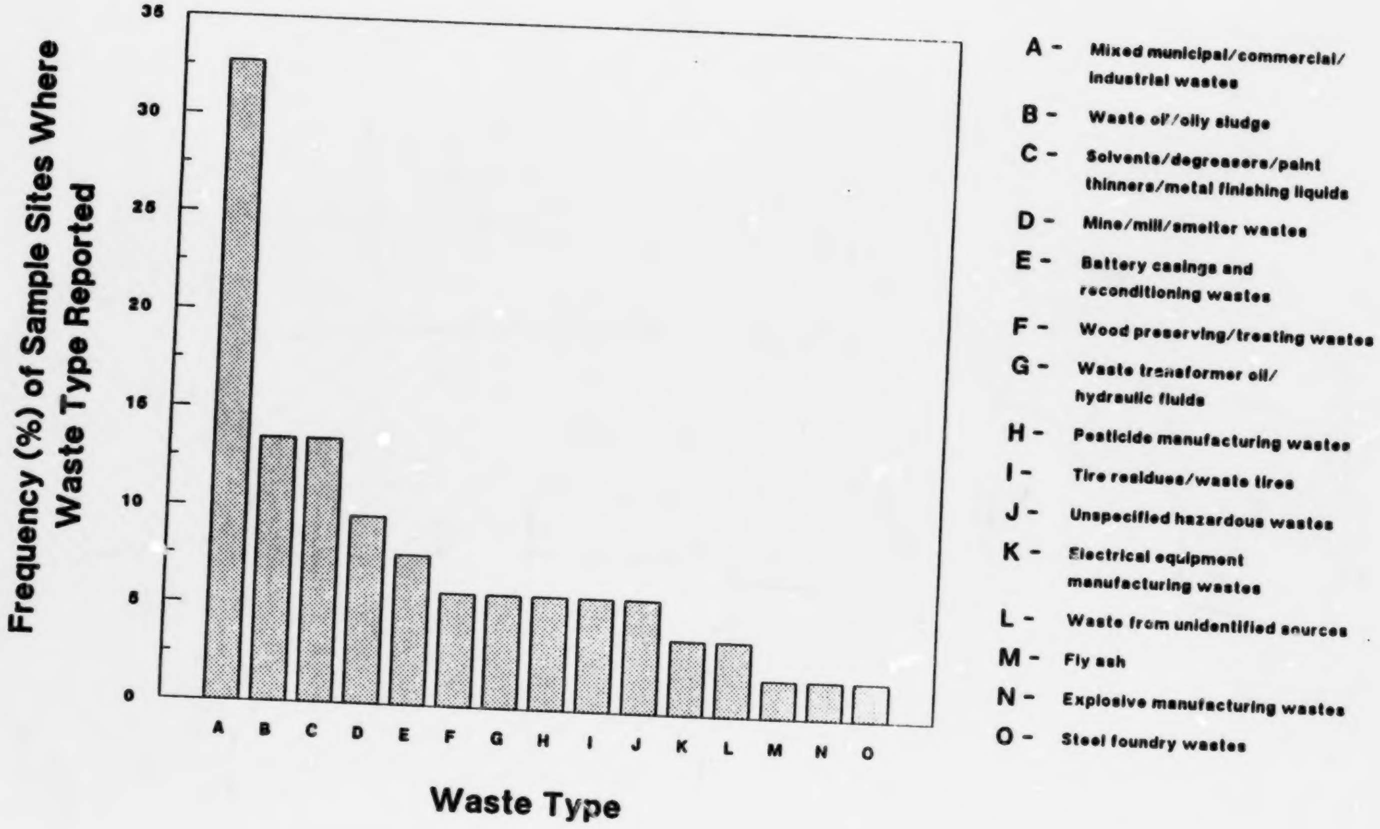


EXHIBIT I-3

FREQUENCY OF WASTE MANAGEMENT PRACTICES AND ENVIRONMENTAL SETTINGS IN THE 52-SITE SAMPLE

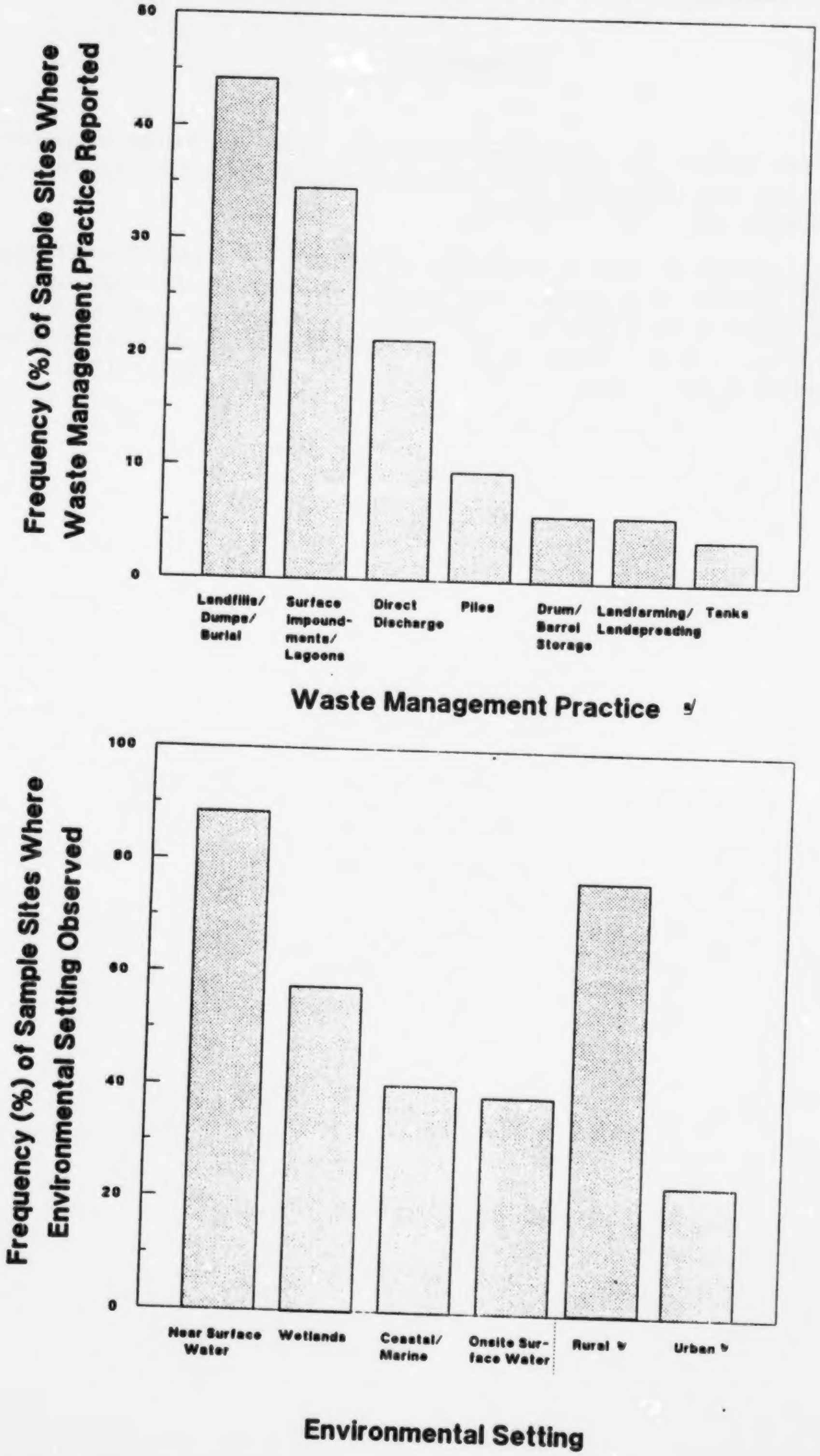


EXHIBIT 3 (continued)

FREQUENCY OF WASTE MANAGEMENT PRACTICES AND ENVIRONMENTAL SETTINGS IN THE 52-SITE SAMPLE

FOOTNOTES

a/ While several of the sites employed more than one waste management practice, these are the practices that were principally implicated as the sources of hazardous substance releases.

b/ Site environments were classified as generally rural if surrounding land uses are described in reports as being predominantly agricultural, rural, residential, or light industrial in combination with one or more of the preceding land uses. Site environments were classified as generally urban if surrounding land uses were described as commercial and/or industrial.

CHAPTER 4

NATURE AND EXTENT OF ECOLOGICAL THREATS AT SUPERFUND SITES

In this report, the term "nature" of ecological threats refers to qualitative descriptions of the types of threats, including an identification of the environmental media contaminated, the principal contaminants involved, the biota or ecosystem potentially affected, and the type of adverse effects. The "extent" of threats, on the other hand, refers to a quantitative characterization of threats, such as estimates of areal extent of contamination, the number of times contaminant concentrations exceed relevant criteria, or the probability of occurrence of an effect.

Detailed data on the nature and extent of ecological threats at each of the 52 sites studied in this project are presented in Appendices B and C. In this chapter, the data are organized into summary exhibits to highlight trends and key findings across the sample as a whole. The chapter is divided into four main sections. In Section 4.1, the amount of ecological threat documentation on which the summary data are based is reviewed. Sections 4.2 and 4.3 summarize data concerning the nature of threats and the extent of threats, respectively. Finally, trends based on the sample data are analyzed in Section 4.4.

4.1 Amount of Documentation

The type and amount of documentation reviewed for the 52 sites is a critical factor to consider when interpreting the results. For example, it would be wrong to conclude that there are no threats to terrestrial ecosystems in the 52-site sample if very few of the sites were analyzed for terrestrial effects. Therefore, in this section, the documentation reviewed is analyzed briefly in terms of the extent to which ecological threats were assessed and the common types of ecological threats that were not addressed or addressed only superficially. This analysis is presented here only to help interpret the results that are summarized in the rest of Chapter 4 and in Chapter 5.

The extent of documentation and level of effort devoted to ecological threat assessment varied substantially across the 52 sites included in the sample. In order to characterize and compare the ecological assessment efforts at the sites, the site reports were ranked from 1 to 4 in terms of the level of detail devoted to ecological threats. A 1 was assigned to reports with the least detail and a 4 was assigned to reports with the most detail. It is important to clarify that a category 1 or 2 assessment did not always appear inadequate. Assessments that were put in these categories appeared sufficient at a few sites that were in generally industrialized areas or, based on available information, seemed to pose little ecological threat. The criteria used for each of these categories are summarized below.

- Site reports were put into category number 1 if one or more of the following conditions were met:
  - -- samples of environmental media or biota were not taken, or were taken only for the purpose of analyzing human health risks (e.g., only analysis of fish or livestock consumed by man);
  - -- there was no analysis or discussion of observed or predicted effects to biota, except to point out that adverse effects might occur.
- Site reports were put into category 2 if one or more of the following conditions were met:
  - -- contaminant concentrations in environmental media were measured or predicted and compared to ecological protection criteria, but there was no analysis of contaminant levels in biota;
  - -- contaminant levels in biota were examined, but primarily for the purpose of human health risk assessment;
  - -- potential effects to biota were examined simply and qualitatively, but based on very little to no site-specific information (such as an identification or inventory of species actually in the vicinity).
- Site reports were put into category 3 if the conditions specified for category 2 plus one or more of the following conditions were met:
  - -- environmental media were sampled and limited sampling and analysis of biota was performed for the purpose of ecological threat assessment;
  - -- a comparison of environmental media concentrations to ecological protection criteria was coupled with a relatively thorough analysis of species actually present;
  - -- a relatively detailed discussion was provided on the extent and magnitude of observed effects to biota at the site;

  - site-specific quantitative or qualitative judgments were made at the population or community level.

- Site reports were put into category 4 if:

  - detailed environmental media and biota sampling was conducted for the purpose of ecological threat assessment (e.g., biota on multiple trophic levels or potentially exposed through different pathways were examined); and

  - site-specific quantitative or qualitative inferences were made at the ecosystem level of organization.

Based on this classification system, it was determined that ecological threats were explicitly addressed at 46 (roughly 89 percent) of the 52 sites included in the sample (i.e., the assessment at 6 sites was classified as category 1). Of these 46, the assessment of ecological threats was classified as category 2 for 18 sites, category 3 for 19 sites, and category 4 for 9 sites. Therefore, the ecological threat data presented in the rest of this part of the report as well as in Appendices B and C are based on a body of literature that, for the most part, provides a relatively detailed evaluation of ecological threats at Superfund sites.

However, the summary data presented in Sections 4.2 and 4.3 that follow do not or rarely address certain types of ecological threats because those threats were infrequently examined in the site reports (not necessarily because those threats did not exist). Observed effects to terrestrial organisms were often not addressed or addressed very superficially in the site reports. Observed or predicted effects at the population, community, or ecosystem levels were also usually not addressed. Analyses of effects at these levels was limited to approximately nine sites. The reports reviewed also provided little analysis of: (1) alterations of or adverse effects to habitats; (2) effects of ecological exposures through the food chain, with subsequent threats to organisms at higher trophic levels; (3) specific toxic effects caused by the exposure of biota to contamination; and (4) the probability of various adverse ecological effects (i.e., ecological risk).

4.2 Nature of Threats at 52 Sample Sites

Data on the type and relative frequency of ecological threats at the 52 sample sites are summarized in Exhibits I-4 through I-7. These exhibits provide summaries across the sample as a whole; information on the nature of ecological threats at individual sites is presented in Appendix B, and Appendix C presents more detailed summaries of the data than presented in this chapter. Exhibits I-4 through I-7 are organized to show certain categories of parameters that relate to ecological threats (e.g., type of ecosystem affected, principal contaminants, biota contaminated, and biota exposure pathways) and the approximate number of sites, out of 52, that fit into those categories. Because considerable judgment and uncertainty was involved in placing each site into the defined categories, the numbers in the exhibits are approximate and should be used only to compare the relative frequency of occurrence of the different parameters.

As shown in Exhibit I-4, the general type of ecosystem most frequently affected was freshwater systems. Surface water, surface water sediments, soil, and ground water (that discharges into surface waters) were all frequently observed or projected to be contaminated. In terms of principal contaminants (see Exhibit I-5), lead and volatile organic compounds were the contaminants most frequently observed in the environment; however, they were not necessarily the contaminants posing the greatest ecological risks at all sites. A variety of other inorganics and organics was also frequently observed at these sites. Exhibits C-1 and C-2 in Appendix C provide a more detailed summary of data on the type of ecosystem affected, media contaminated, and principal contaminants at the 52 sample sites.

Exhibit I-6 identifies the biota that were observed or projected to be contaminated at the sample sites, as well as the observed and projected effects caused by this contamination. As shown, the predominant types of organisms contaminated were fish, vegetation, and aquatic invertebrates. A variety of toxic effects to aquatic fauna were observed at approximately 25 percent of the sites and projected at another 45 percent. Exhibit I-6 also shows that certain types of organisms, such as mammals and birds, were rarely observed to be contaminated, although the contamination of these organisms was commonly projected. Similarly, most adverse effects in general were projected rather than actually observed, with some effects (e.g., toxicity to terrestrial fauna) being very rarely or never observed. Additional detail on the biota contaminated and biological/ecological effects across the 52-site sample is provided in Exhibits C-1 and C-2 in Appendix C.

Exhibit I-7 focuses on actual and projected effects to "sensitive or special" environments in the sample. For the purpose of this exhibit, wetlands were considered sensitive environments regardless of their size. Estuaries were categorized as sensitive/special environments for the purpose of this project because they are often important spawning areas. Also, park lands and nature study areas were grouped into a sensitive/special environment category, not because these types of environments are necessarily sensitive ecologically, but because they may be sensitive publicly. A summary of the nature of effects to these categories of environments is provided in Exhibit C-3 in Appendix C.

4.3 Extent of Threats at 52 Sample Sites

The reports reviewed for this project contained limited quantitative information on the extent of ecological threats, and most of the information that was available was limited to only a few sites. In particular, quantitative estimates of ecological risk (i.e., predicted impacts) were almost non-existent. Available information for these sites is summarized in Exhibit I-8 and is presented in greater detail in Exhibit C-4 in Appendix C.

EXHIBIT I-4

ECOSYSTEMS AND MEDIA OBSERVED OR PROJECTED TO BE AFFECTED/CONTAMINATED IN THE 52-SITE SAMPLE

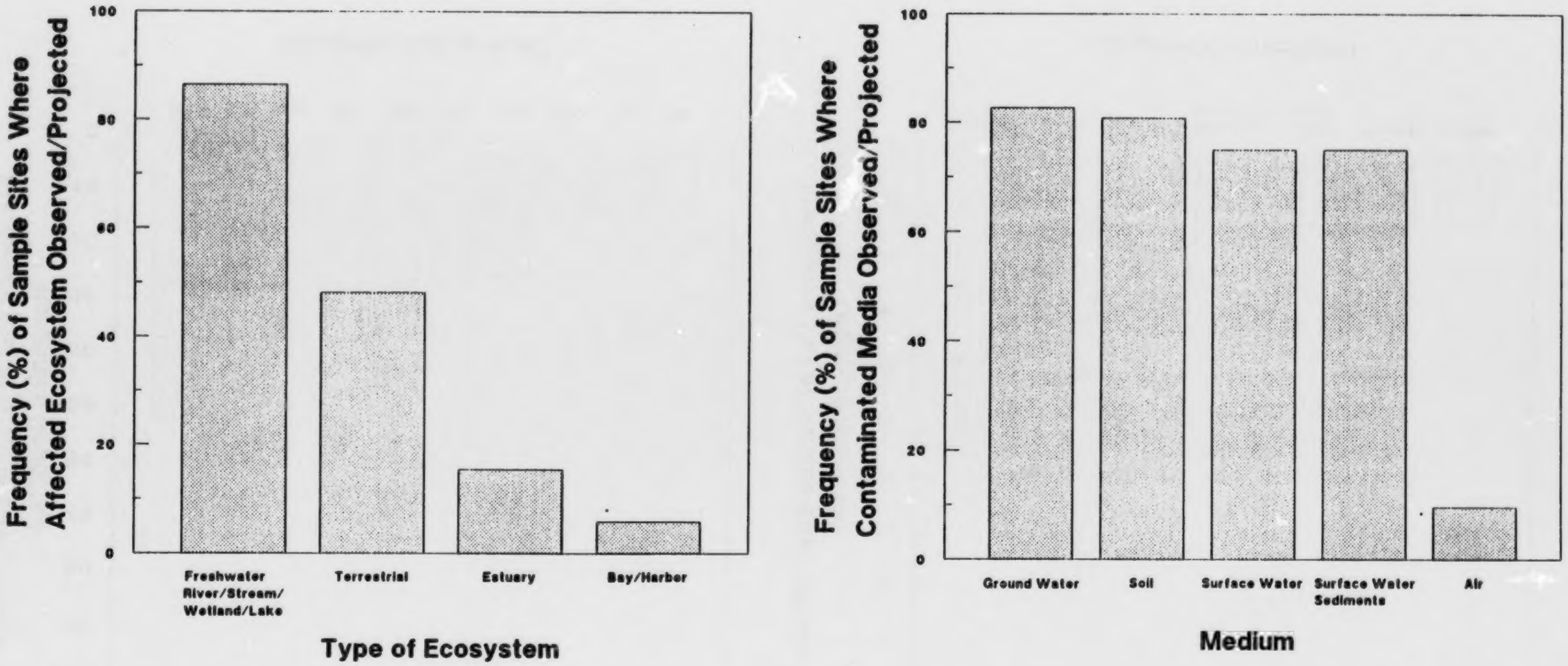
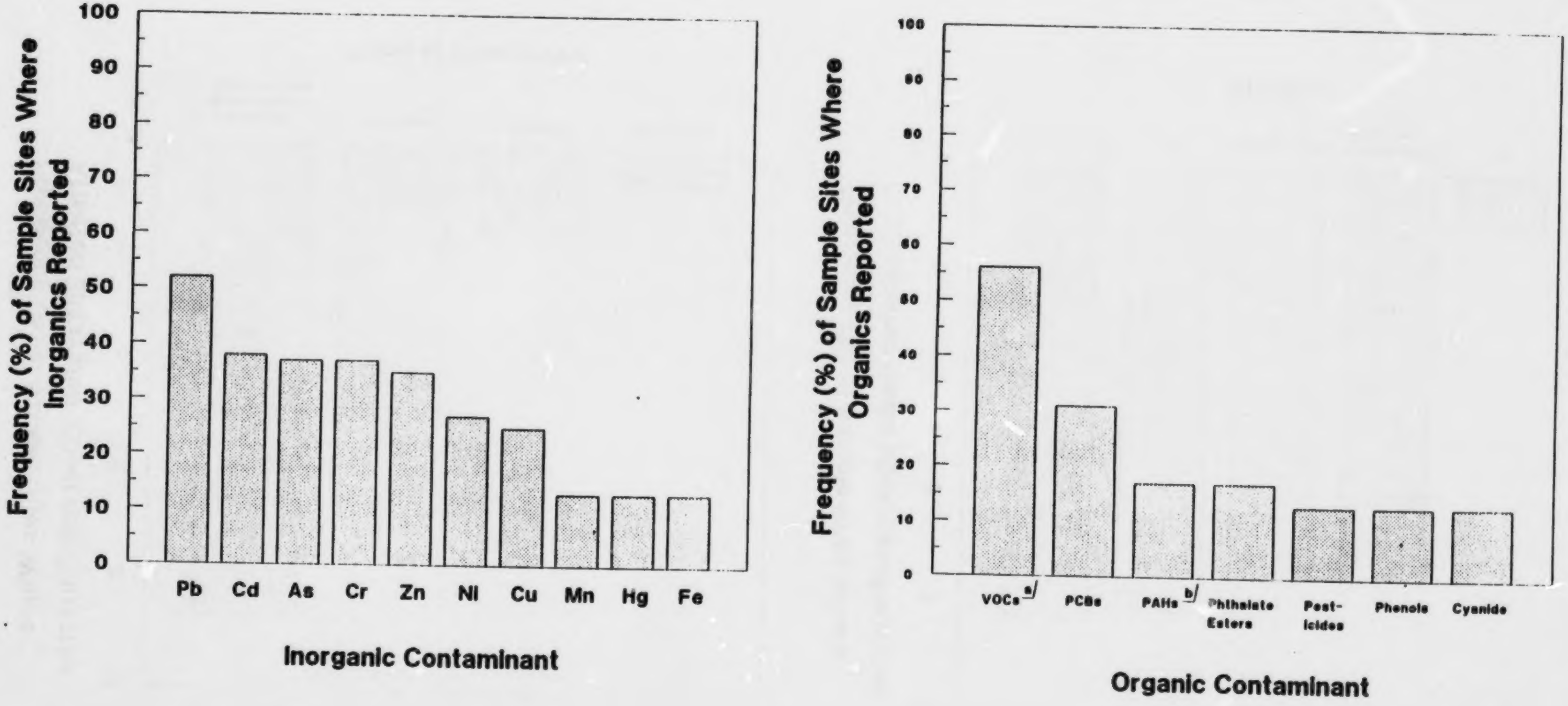


EXHIBIT I-5

PRINCIPAL CONTAMINANTS IN THE 52-SITE SAMPLE



a/ Volatile organic compounds. This category includes a variety of both aromatic hydrocarbons (e.g., benzene, toluene) and aliphatic hydrocarbons (e.g., trichloroethylene and vinyl chloride).

b/ Polynuclear aromatic hydrocarbons (e.g., benzo(a)pyrene, naphthalene).

EXHIBIT I-6

NATURE OF BIOTA CONTAMINATION AND BIOLOGICAL/ECOLOGICAL EFFECTS IN THE 52-SITE SAMPLE

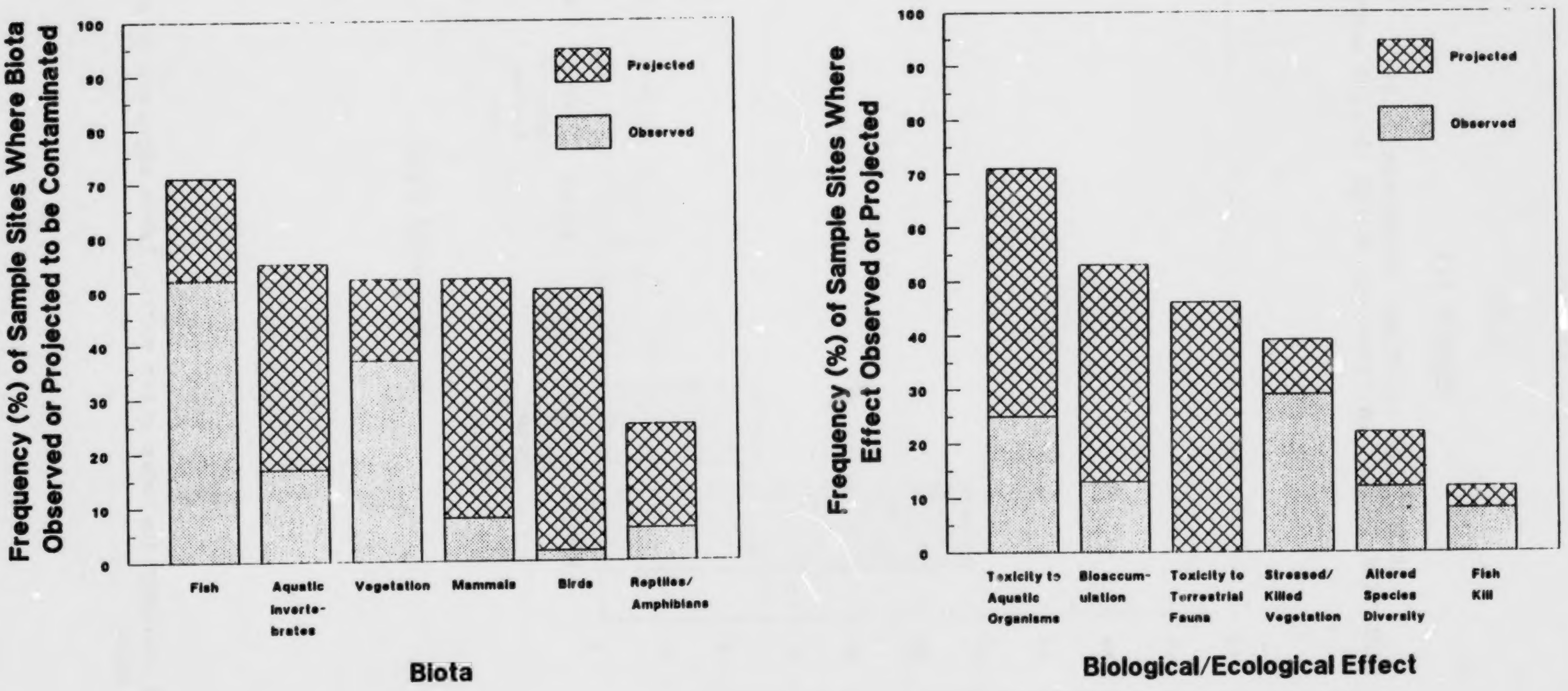
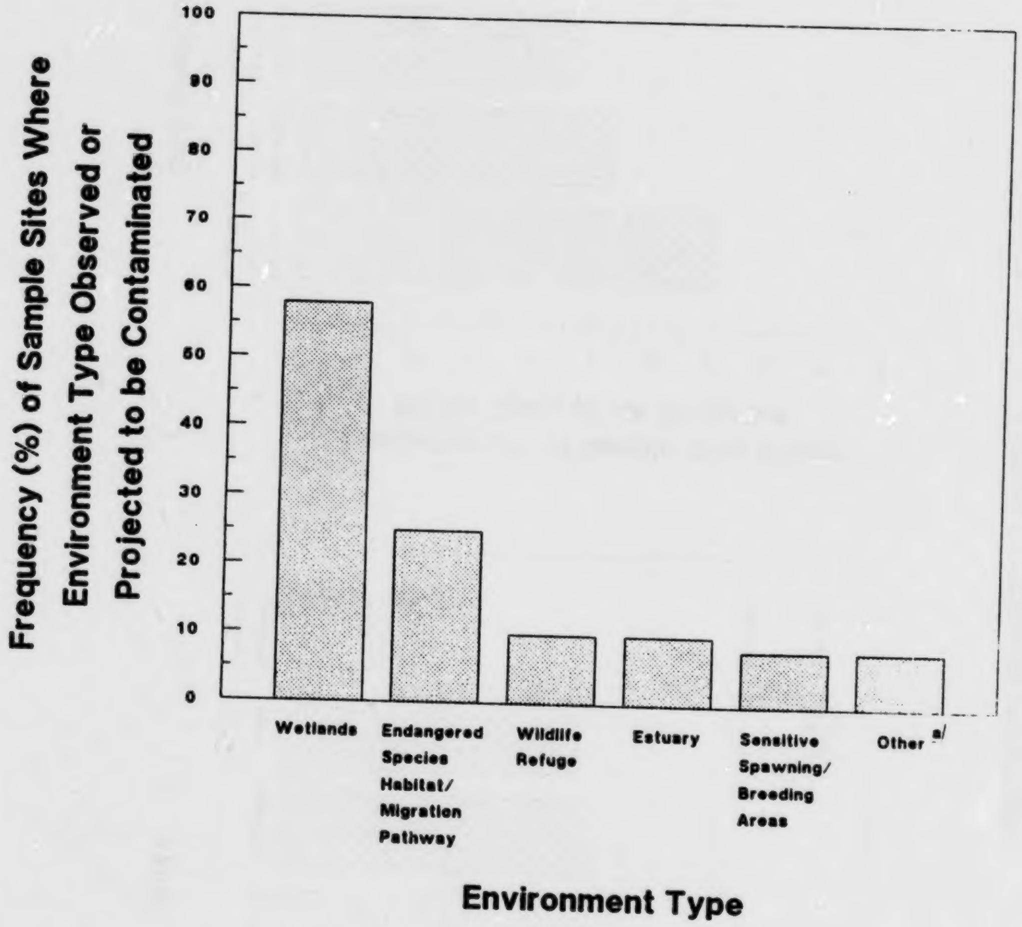


EXHIBIT I-7

OBSERVED OR PROJECTED CONTAMINATION OF SENSITIVE/SPECIAL ENVIRONMENTS IN THE 52-SITE SAMPLE



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a/ This category includes state parks, lakes adjacent to parks, and nature study areas.

EXHIBIT I-8

EXTENT OF ECOLOGICAL IMPACTS a/

CATEGORY OF IMPACT	NO. OF SITES WITH INFORMATION ON EXTENT	CUMULATIVE AREAL EXTENT	CONTAMINANTS/MAGNITUDE b/
Surface Water Contamination	9	▪ 209 stream miles; and ▪ 3,954 acres	▪ Concentrations of 8 metals, PCBs, and pentachlorophenol exceed AWQC 1.5 to 414,000 times.
Contamination of Surface Water Sediments	9	▪ 209 stream miles; and ▪ 3,937 acres	▪ Observed contaminants include 7 metals, PCBs, and asbestos. ▪ Concentrations frequently exceed background levels, ranging from 15 to 820 times. ▪ Volumes of 4 metals and PCB remaining in sediments range from 10 pounds to 229 metric tons per site.
Soil Contamination	15	2,240 acres	▪ Observed contaminants include 6 metals, PCBs, phenols, asbestos, nitroaromatics, and other organics. ▪ Volumes of contaminated soil range from 17,000 to 535,000 cubic yards per site. ▪ Concentrations frequently exceed background levels, ranging from 3 to 2,600 times.
Fish Kills	4	27 stream miles	▪ Severity of observed fish kills ranges from 100% to 10% for affected areas.
Defoliation	5	2,014 acres	▪ Observed contaminants include 3 metals and pentachlorophenol.
Contamination/ Degradation of Wetlands/Marshes	5	324 acres	▪ Observed contaminants include 2 metals, oils, and PCBs. ▪ Concentrations in sediments frequently exceed background levels.

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a/ Explicit information was provided on the areal extent or magnitude of contamination for 28 of the 52 sites in the sample; information for only those 28 sites is included in this exhibit. See Exhibit C-4 in Appendix C for a more detailed presentation of these data.

b/ Indicates degree to which contaminant levels exceed criteria such as ambient water quality criteria (AWQC). Information on the exceedance of criteria is not provided for soil and sediment contamination because generally applicable criteria for these media do not exist.

When available, information on both the areal extent and magnitude of contamination and effects is provided.

Based on these sample sites, there are three main observations about the extent of ecological threats at Superfund sites. First, the areal extent and magnitude of contamination/effects vary significantly from site to site. For example, roughly 300 feet of tributary sediments at the Re-Solve site are contaminated with PCBs, while the PCB contamination in sediments in Hudson River extends approximately 200 miles. The second observation is that the ecological threats at some sites can be very intense. For example, roughly 2,000 acres of a mountain side in the vicinity of Palmerton Zinc have been completely defoliated. Third, even though the extent of contamination at an individual site may be relatively small, the cumulative extent across all sites may be large. For example, ignoring the magnitude of contamination, the total area of soil contaminated across the 16 sites accounted for in Exhibit I-8 is roughly 2,240 acres (240 acres if Palmerton Zinc is omitted). The significance of this point is made clearer when one considers that there are approximately 1,200 sites on or proposed for the NPL and many of these sites probably have soil contamination.

4.4 Analysis of Trends

This section summarizes how ecological threats discussed above appear to be associated with certain waste stream, waste management practice, and environmental setting factors. In addition, this section examines the common characteristics of sites that appear to have the most severe ecological threats.

4.4.1 Waste Type, Management Practice, and Environmental Setting Factors

Examining the various waste streams represented by the 52-site sample, it does not appear that ecological threats are being caused by only a few waste types or constituents. In fact, Exhibits I-2, I-3, and I-5 suggest that a wide variety of waste types and constituents are contributing to ecological threats at CERCLA sites. The most frequently occurring waste type in the sample (present at 33 percent of the sites) is municipal/commercial/industrial waste commingled in a landfill, with the specific components and sources of these wastes often being unknown. The relatively high frequency of this waste mixture illustrates the point that mixtures of several different chemicals, rather than just one or two chemicals, are probably contributing to ecological effects at most sites. The most frequently encountered inorganics in the sample were lead, cadmium, arsenic, chromium, and zinc; the most frequently encountered organics were volatile organic compounds (e.g., benzene, toluene, trichloroethylene), PCBs, and polynuclear aromatic hydrocarbons (e.g., naphthalene, benzo(a)pyrene). The constituents most frequently linked with fish kills were cadmium, copper, zinc, arsenic, chromium, volatile organic compounds, and phenols; the constituents most frequently linked with vegetation damage were lead, zinc, arsenic, chromium, cadmium, nickel, polynuclear aromatic hydrocarbons, PCBs, and volatile organic compounds.

The most common types of waste management practices resulting in releases at the 52 sites were landfills/dumps and surface impoundments, which together account for roughly 80 percent of the sample. Insufficient information is available to evaluate trends in the design characteristics of these units. As shown in Exhibit I-9, the most commonly observed waste migration pathway was seepage into ground water that in turn discharges to surface water (observed at almost 65 percent of these sites). However, at most sites multiple release and migration pathways from multiple sources were either observed or projected. For example, runoff or erosion was either observed or projected to be an important migration pathway at roughly 70 percent of the sites with landfills, direct discharges were observed to be a source of environmental contamination at approximately 40 percent of the surface impoundment sites, and airborne releases (dusting or volatilization) were projected to be contributors to ecological threats at 50 percent of the sites with landfills or surface impoundments. The routes by which biota were most frequently observed to be exposed were contact with/ingestion of surface water and surface water sediments; however, contact with/ingestion of soil and food chain ingestion also were frequently projected routes of exposure.

In terms of environmental setting characteristics, the factor that appears to have the greatest bearing on reported ecological threats is the proximity of a site to surface water. Almost 90 percent of the sites in the sample were either adjacent to or near (generally within one or two miles) a surface water body. In addition, almost 40 percent of the sites were noted to have surface water onsite, most commonly drainage ditches or small creeks that appear to act as conduits for waste constituent migration, as well as habitat for aquatic receptors. The proximity to a wetland, swamp, or marsh also appears to be an important factor in determining ecological risks. Roughly 60 percent of the sites were near this type of ecosystem.

4.4.2 Common Characteristics of Sites With Relatively Severe Ecological Threats

There are five sites in the sample that, based on the documentation reviewed, appear to have particularly severe ecological threats. These sites are Hudson River, Iron Mountain Mine, New Bedford Harbor, Outboard Marine Corporation, and Palmerton Zinc. See Appendix B for a summary of the ecological effects at these sites.

These five sites exhibit very few common characteristics; however, there are some noteworthy trends. First, the media principally contaminated at each site are surface water and surface water sediments. The only exception to this is Palmerton Zinc, which has significant soil and terrestrial vegetation contamination in addition to surface water and sediment contamination. The surface water ecosystem contaminated at three of the sites was noted to be habitat for commercial species or important spawning areas (such as estuaries). The contaminants present at all of the sites are bioaccumulative and environmentally persistent: PCBs are a major contaminant at three of the sites, while three of the sites are contaminated with copper, cadmium, zinc, and/or lead. The contamination at three of these sites can be traced primarily to a single facility or source; the exceptions are Hudson River, which received discharges from two separate facilities, and New Bedford

EXHIBIT I-9
MAJOR RELEASE SOURCES, MIGRATION PATHWAYS, AND EXPOSURE PATHWAYSa/

Release Source	Release/Migration Pathways		Biota Exposed		Media Through Which Biota Exposed/Exposure Routes	
	Actual	Projected	Actual	Projected	Actual	Projected
Landfills (21)b/	Seepage into ground water that discharges to surface water (14) Runoff/erosion (7) Direct discharge (3)c/ Accidental release/ spill (3)d/ Flooding (1)	Runoff/erosion (7) Dusting/volatilization (7) Seepage into ground water that discharges to surface water (6) Flooding (2)	Fish (8) Aquatic or terrestrial vegetation (6) Aquatic invertebrates (5) Amphibians/reptiles (1)	Mammals/birds (17) Aquatic invertebrates (14) Fish (13) Amphibians/reptiles (10) Aquatic or terrestrial vegetation (5)	Contact with/ ingestion of surface water sediments (8) Contact with/ ingestion of surface water (7) Contact with/ ingestion of soil (3) Food chain ingestion (3)	Contact with/ ingestion of soil (15) Food chain ingestion (15) Contact with/ ingestion of surface water (13) Contact with/ ingestion of surface water sediments (11) Inhalation (8)
Surface Impoundments/ Lagoons (16)b/	Seepage into ground water that discharges to surface water (10) Direct discharge (7) Accidental release/ spills (5)e/ Runoff/erosion (2)f/ Dusting/volatilization (1)	Dusting/volatilization (12) Seepage into ground water that discharges to surface water (6) Runoff/erosion (1)	Fish (8) Aquatic or terrestrial vegetation (6) Aquatic invertebrates (3) Amphibians/reptiles (1)	Mammals/birds (15) Amphibians/reptiles (15) Aquatic invertebrates (13) Fish (8) Aquatic or terrestrial vegetation (7)	Contact with/ ingestion of surface water (8) Contact with/ ingestion of surface water sediments (7) Contact with/ ingestion of soil (5) Food chain ingestion (2)	Contact with/ ingestion of soil (11) Inhalation (11) Contact with/ ingestion of surface water (8) Contact with/ ingestion of surface water sediments (8) Food chain ingestion (13)

EXHIBIT I-9
MAJOR RELEASE SOURCES, MIGRATION PATHWAYS, AND EXPSOURE PATHWAYS

FOOTNOTES

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a/ The numbers in parentheses represent the approximate number of sites, out of 52, that have the given release sources, migration pathways, and biota exposure pathways. Because of uncertainties in classifying each site into the categories used in the table, these numbers are only approximate and indicative of the relative frequency of occurrence of the release/migration/exposure pathways.

b/ As shown in Exhibit 3, there are 23 sites in the 52-site sample that have landfills or dumps and 18 sites with surface impoundments or lagoons. There are two sites, however, that have both a dump area and surface impoundments, as well as other potential release sources (the Sand Creek Industrial Site and the Velsicol Site). Because the release/migration/exposure pathways associated with the different waste management practices at these sites could not be differentiated based on the site information available, the sites are not accounted for in this table.

c/ At these sites, contaminated ground water is collected and then discharged to a surface water body.

d/ Accidental releases or spills from landfills were counted for the purpose of this exhibit as surface releases from contained wastes prior to burial, such as a breach of a drum or other container.

e/ For the purpose of this exhibit, accidental releases or spills from surface impoundments were considered overflow events or incidences in which a surface impoundment berm was significantly breached (not seepage into ground water that might have occurred during routine operation).

f/ Runoff and erosion was considered as a secondary release pathway for surface impoundments at two sites where: (1) the impoundments had been closed and covered, and the cover and contained residual contaminants were noted to be eroding; and (2) residual surface soil contamination caused by a spill was noted to be eroding.

Harbor, which appears to have been contaminated by multiple sources. Two of the sites can be categorized as "special waste" sites, as defined under the RCRA program: Palmerton Zinc (a smelter) and Iron Mountain Mine. Finally, contaminants were reported to be released or migrating from most of the sites through multiple pathways; the most common release/migration pathways are direct discharges and runoff or erosion.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

This chapter discusses issues related to the overall significance or importance of the ecological threats summarized in Chapter 4. In particular, Section 5.1 provides generalizations across the 52 sites studied in this project, and Section 5.2 discusses generalizations across the universe of NPL and all Superfund sites.

5.1 Generalizations Across Sample of 52 Sites

With respect to the nature of threats, most (roughly 90 percent) of the sites pose a threat to surface water ecosystems, and in particular, freshwater rivers, lakes, and wetland systems. Threats to terrestrial ecosystems have been observed or projected less frequently (at slightly less than 50 percent of the sites), but this may be more a function of the extent to which terrestrial effects were studied rather than a true indication of the frequency of these effects. As discussed in Section 4.1, terrestrial effects generally were analyzed in the reports reviewed less rigorously than aquatic effects. Soil, ground water, surface water, and surface water sediments have all been frequently observed to be contaminated at the sample sites. The biota most frequently observed to be contaminated were fish, aquatic invertebrates, and vegetation; however, birds and mammals were projected to be contaminated at a large number of the sites. For example, fish or aquatic invertebrates were observed to be contaminated at roughly 60 percent of the sites, while birds or mammals were projected to be contaminated at approximately 70 percent of the sites. A variety of toxic effects to aquatic fauna were observed at approximately 25 percent of the sites and projected at another 45 percent. In addition, fish kills were observed at almost eight percent of sites, bioaccumulation within the aquatic food chain was observed or projected at roughly a third of the sites, and decreased aquatic species diversity was observed at 13 percent of the sites. When noted, adverse terrestrial effects usually took the form of damaged or killed vegetation, loss of habitat, contamination or loss of food sources, and in a few cases, projected toxic effects to birds and mammals. At many sites, the adverse effects manifested in terrestrial fauna (if any) are uncertain.

Based on the limited amount of quantitative information available, the extent of threats varies widely across the sample, both in terms of the area affected and magnitude of impact. As discussed in Section 4.4.2, there are five sites (approximately 10 percent) that appear to present particularly severe ecological threats, characterized by high levels of environmental contamination spread over relatively large areas with large populations of organisms that are (or could be) exposed. There is an equal number that appears to present relatively minor threats, generally characterized by low levels of environmental contamination confined to small areas and relatively small numbers of potential ecological receptors. Therefore, based on the documentation reviewed, the majority (roughly 80 percent) of the sites can be categorized as relatively moderate in terms of ecological threats. It is important to clarify that many of the sites grouped into this "moderate" category have resulted in adverse effects and even death to some biota, or have caused environmental contamination that is likely to cause adverse effects to biota. However, the threats at the majority of these sites were categorized as moderate, for the purpose of relative ranking only, mainly because: (1) the area affected generally appears to be small to moderate in size (usually less than tens of acres) and the biota affected generally appear to be limited to organisms close to the site; and/or (2) contaminant levels appear to be below acutely toxic levels in most areas and the potential for and exact nature of effects of chronic exposures at these sites is not well understood.

Insufficient information is available to draw firm conclusions with respect to the significance of ecological threats in the sample. In particular, data on the extent of environmental problems are generally lacking, it appears that the threats to terrestrial organisms are not well known, there generally are few ecological toxicity reference levels by which to assess the magnitude of environmental contamination, and the overall effects to ecosystems are not well understood. In addition, there is no official EPA guidance or policy on what constitutes a "significant" ecological impact or risk at Superfund sites. Nevertheless, generalizations can be made concerning the following four aspects that relate to the significance of ecological effects: the intensity of the effects, the duration of the effects, the extent to which unique or particularly valuable resources are threatened, and the overall context of the threats (i.e., whether they are local, regional, national, or global).

As demonstrated by several sites in the sample, the adverse ecological effects at Superfund sites can be very intense, including death to aquatic and terrestrial organisms and complete devastation of habitat. In addition, almost all of the sites in the sample have contaminants present that are acutely toxic to aquatic organisms when present in sufficient concentrations. In the sample studied, however, very intense (or acute) effects were observed or projected at only a small portion of the sites or appeared to be limited to small areas. Most sites appear to present more of a long-term threat that has not yet resulted in adverse effects that are easy to detect.

Based solely on the types of contaminants observed, it appears that ecological exposures and adverse effects caused by contamination at the sample sites could persist for long periods of time if no response action were taken. Most of the sites are contaminated with chemicals that are persistent and bioaccumulative (e.g., PAHs, PCBs, lead, and cadmium).

Ecological threats may be considered by some to be more significant if the resources at risks are particularly valuable (i.e., unique, vulnerable, commercially significant, or recreationally important). In that regard, Exhibit I-7 shows that almost 60 percent of the sample sites appear to be threatening wetland/marsh/swamp systems, and 25 percent may be threatening endangered species or their habitat. In addition, roughly 10 percent of the sites are located in or near wildlife refuges and approximately seven percent are possibly threatening aquatic habitat noted in the site reports to be sensitive spawning areas for fish. The commercial resources that appear to be at highest risk are fish and shellfish; the reports reviewed for approximately

17 percent of the sites noted observed or projected threats to fish or shellfish that appear commercially significant. Very little data are available on the recreational value of the resources potentially affected, except that roughly seven percent of the sites may have contaminated areas likely to be used for recreational purposes (e.g., state parks, lakes adjacent to parks, and nature study areas).

Finally, virtually all of the sites individually pose ecological threats that are local in nature. The possible exception is the 200-mile stretch of contamination at the Hudson River site, which conceivably could cause regional effects. However, the threats at individual sites must be considered along with the fact that there is a large number of Superfund sites in order to assess the aggregate national extent of ecological threat.

There are several sources of uncertainty concerning these generalizations. The greatest uncertainty is associated with the amount of ecological threat documentation on which the generalizations are based. As discussed in Section 4.1, the scope of many of the site-specific assessments reviewed in this study was rather limited, often not including analyses of key endpoints (e.g., effects to terrestrial organisms, effects on the population or community levels of organization, and habitat alterations). In general, the reports reviewed also focused heavily on adverse effects that were being exhibited at the time of study, providing less detail on chronic threats that could result in adverse effects in the future. Additional uncertainty is created by limitations in the methods used to conduct this study, as described in Chapter 2.

5.2 Generalizations Across All Superfund Sites

The sample of 52 sites studied in this analysis may not be statistically representative of all Superfund sites, and it certainly was not a statistically based sample of the site universe.[2] The sample was drawn from a limited set of selectively identified sites, and probably is biased toward sites with more obvious ecological threats (i.e., when compared to the universe of all sites, the sample of 52 likely contains a larger fraction of sites with more obvious ecological threats because they were recognized and investigated). The sample may also be biased toward sites with more severe ecological threats, although that is less certain. Furthermore, the representativeness of the sample results is uncertain given the fact that comprehensive efforts to identify sites where ecological threats exist generally have not been made prior to this study. For these reasons, statistically valid extrapolations of the sample results to the general population of Superfund sites are not possible.

Simply for the purpose of illustration, however, the sample results can be generalized over the entire Superfund site universe if it is assumed that the 52 sample sites examined here are representative of sites having the potential for significant ecological threats. Using information collected in this study, it is possible to make very rough, preliminary estimates of the number of NPL sites that might have significant ecological impacts or risks. A total of 247 sites, most of them on or proposed for the NPL, were identified through personal contacts and a literature review as having the potential for significant ecological threats. There are conflicting reasons, however, why this number may overestimate or underestimate the total number of NPL sites that have the potential for significant ecological effects.

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[2] At this time, a retrospective analysis of a statistically drawn sample would have limited value because of severe ecological data limitations for the sites.

- There is likely to be a smaller number of NPL sites that have the potential for significant ecological threats because the 247 sites probably include several sites with minor effects. If the 52 sample sites examined in detail are representative of the 247, approximately 10 percent of the sites would present relatively minor threats. Using this fraction, therefore, a rough lower bound estimate of the total number of NPL sites with the potential for significant ecological threats is 247 minus 10 percent, or roughly 220 sites. It is recognized, however, that the total number of NPL sites that have the potential for significant ecological threats may be even smaller than 220. This is because the sample of 52 sites is probably biased toward sites with greater ecological threats (i.e., when compared to the 247 sites, the sample of 52 likely contains a smaller fraction of sites with minor ecological effects).

- A major reason why there are probably more than 247 NPL sites that have the potential for significant ecological threats is that many NPL sites have not entered the detailed study (RI/FS) phase of the Superfund program. As a result, many sites probably have not been evaluated in any detail from the standpoint of ecological threats and could not, through the interviews and literature review conducted in this study, have been identified as having the potential for significant ecological effects. Based on the sites identified in this study, the RI/FS workplan phase represents a reasonable point in the remedial response process that must be reached before one can have any confidence that ecological threats exist at a site. There are approximately 700 sites at the RI/FS workplan phase; therefore, given the above logic, the 247 sites identified here are out of a possible total of roughly 700. Assuming this ratio is valid for all 1,200 sites on or proposed for the NPL, a rough upper bound estimate of the total number of NPL sites with the potential for significant ecological effects is 1,200 times 35 percent (i.e., 247/700), or 420 sites. It is recognized, however, that the total may be greater than 420 because:

(1) many of the individuals contacted through the course of identifying the 247 sites gave the name of a few example sites, while acknowledging the presence of additional, unnamed sites that also have the potential for significant threats; and (2) it is likely that the 247 sites represent sites that have readily apparent or sensational ecological effects (i.e., there are possibly additional sites with ecological effects that will become apparent only after long-term exposure).

Therefore, weighing these conflicting factors, a rough estimate of the total number of NPL sites with the potential for significant ecological threats is between 220 and 420 sites, which is between approximately 18 percent and 35 percent of all sites either on or proposed for the NPL. For the reasons given above, however, the actual number could be either smaller than 220 or larger than 420. Furthermore, based on the detailed review of 52 sites, the number of NPL sites currently exhibiting relatively severe ecological effects is probably much smaller. The estimated range of sites with the potential for significant threats is consistent with an earlier survey of 277 Superfund sites done by OPA (EPA 1985), which estimated that approximately 22 percent of all NPL sites have the potential to cause significant natural resource injuries.

Although virtually all of the 247 sites identified in this study can be categorized as NPL sites, there is little reason to believe that non-NPL sites pose less of an ecological threat, because ecological threats are given limited consideration when placing sites on the NPL (i.e., in the current Hazard Ranking System). Therefore, if it is assumed that the estimated percentage of NPL sites potentially posing significant ecological threats is valid for the 15,000 or so sites currently listed in CERCLIS and potentially posing threats addressable under CERCLA,[3] the total number of Superfund sites with the potential for significant ecological threats would be between 2,700 and 5,300. This probably overestimates the actual number because some of the sites in CERCLIS probably involve minor or inconsequential releases; however, the large number illustrates the potential magnitude of the problem. Again, the total number of sites currently exhibiting relatively severe ecological effects is probably much smaller.

If it is assumed that the 52 sample sites examined here are representative of sites having the potential for significant ecological threats, the characterization of ecological threats at the sample sites would illustrate the nature of threats that may occur at all Superfund sites having the potential for significant ecological threats. Recognizing this limitation, the following conclusions about all Superfund sites can be made. Many sites have probably caused soil, ground-water, surface water, and surface water sediment contamination. In addition, many have probably contaminated wetlands or have damaged vegetation. Cumulatively, this may translate into a potentially large loss of habitat for the nation's flora and fauna, some of which may be endangered or commercially/recreationally valuable. Fish or aquatic invertebrates are also probably contaminated and displaying toxic effects at many of the sites and, while probably fewer terrestrial organisms (birds and mammals) are contaminated and to a lesser extent, there also is widespread potential for wildlife to be adversely affected.

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[3] CERCLIS contains approximately 31,000 sites, of which approximately 16,000 have been classified based on a preliminary assessment or site inspection as clearly posing no significant threats addressable under CERCLA (i.e., categorized by EPA as "no further response action planned"). Also, it is important to clarify that 31,000 does not represent the complete universe of Superfund sites, but rather the Superfund sites that have been identified to date.

In order to make quantitative projections about the extent of ecological threats across all Superfund sites, a number of assumptions concerning this study's results would have to be made. In particular, one would have to assume that: (1) the 52 sites studied in this project are representative of all sites with the potential for significant ecological effects; (2) the subset of 28 sites for which data are available on the extent of ecological threats is also representative; (3) available data on the extent of ecological threats are complete and accurate; and (4) the above estimates of the total number of Superfund sites with the potential for significant ecological threats are accurate. If these assumptions are valid, the following preliminary estimates can be made of the aggregate national extent of ecological threats caused by Superfund sites:

- Surface water contamination: Seventy-five percent of the 52-sample sites has either observed or projected surface water contamination. Ignoring the magnitude of this contamination, the geometric mean[4] of available data on the areal extent of surface water contamination is 3 stream miles contaminated per site. If these numbers are assumed to be valid for all 5,300 Superfund sites estimated to have the potential for significant ecological threats, the national extent of surface water contamination caused by Superfund sites would be 12,000 stream miles contaminated. This figure may include some double counting because several sites have the potential to contaminate the same stream miles. Assuming the sample results are representative for all sites, contaminant concentrations over this large distance would range from slightly greater than AWQC in certain areas to more than 400,000 times AWQC in some areas.

- Surface water sediment contamination: Seventy-five percent of the sample sites also has observed or projected contamination of surface water sediments; the geometric mean of the sample results is roughly 2 stream miles of sediments contaminated above background levels per site. Applying these numbers in the same manner as described above for surface water contamination, the national extent of sediments contaminated above background levels as the result of Superfund sites could be 8,000 stream miles. Again, this figure may include some double counting because several sites may contaminate the same stream miles.

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[4] A geometric mean rather than an arithmetic mean is used for this purpose because the sample sizes are small and the arithmetic mean would be skewed toward an unusually large value at a single site.

- Soil contamination: Soil is observed or projected to be contaminated above background levels at roughly 80 percent of the sample sites, with a geometric mean of approximately 15 acres contaminated per site. If these figures are valid for the upper bound estimate of 5,300 sites that have the potential for significant ecological effects, the total area of soil contaminated by Superfund sites would be 64,000 acres.

- Fish kills: Fish kills were observed or projected at only 11 percent of the sample sites. At sites where fish kills were observed, kills occurred over areas ranging from less than one stream mile to 18 stream miles, with a geometric mean of 3 stream miles per site. If these figures are assumed to be valid for all 5,300 sites estimated to have the potential for significant ecological threats, Superfund sites could cause fish kills in 1,700 stream miles. Based on the sample results, the severity of fish kills could range from 10 percent to 100 percent for affected areas.

- Defoliation: Vegetation was observed or projected to be stressed or killed at 38 percent of the sample sites. When observed, the areas of defoliation ranged from 1 acre to 2,000 acres, with a geometric mean of 11 acres per site. Assuming these figures are valid for all 5,300 sites as done above, the total area of defoliation caused by Superfund sites could be 22,000 acres. Additional areas would be expected to have stressed but not killed vegetation.

- Contamination of wetlands or marshes: Roughly 58 percent of the sample sites had observed or projected contamination of wetlands/marshes, with the geometric mean being approximately 7 acres contaminated per site. Applying these numbers in the same manner as above, the total area of wetlands/marshes contaminated above background levels as the result of Superfund sites could be 22,000 acres.

To help put these estimates in perspective, Keup (1985) estimates that there are approximately 3,250,000 total stream miles in the U.S. The rough estimates given above for surface water and surface water sediment contamination caused by Superfund sites are less than 0.5 percent of the nation's stream miles. According to EPA (1987), it is suspected that severe contamination of sediments with toxicants released from all sources might exist in perhaps 1 percent of the nation's stream miles (not counting possible sediment contamination in the nation's lakes, estuaries, or marine areas). The estimate given above for fish kills caused by Superfund sites is less than 0.1 percent of the nation's stream miles. For comparison, EPA and the Fish and Wildlife Service (1984) have estimated that fish kills caused by all sources have occurred in 15 percent of the nation's stream miles and that toxic substances from all sources have adversely affected fish in roughly 10 percent of the nation's stream miles (not counting fish kills or toxic substance contamination that may have occurred in estuaries, coastal water, wetlands, or the Great lakes). Moreover, the rough estimate given above for the number of acres of wetlands and marshes contaminated by Superfund sites represents less than 0.03 percent of the nation's total inventory of wetlands in the 1970's in the 48 conterminous states (Fish and Wildlife Service 1983). Roughly 20 times more wetlands are lost each year as a result of all other stresses (Fish and Wildlife Service 1983), with agriculture and development alone resulting in an annual loss of roughly 10 times more wetlands than predicted to be contaminated by Superfund sites (EPA 1988). Assuming these estimates are valid, therefore, the relative contribution of Superfund sites to the nation's ecological impacts appears moderate to small. This conclusion generally is supported by other EPA studies (e.g., EPA 1987). Clearly, these numerical extrapolations are highly uncertain; they are provided only to illustrate the possible extent of the problem, and as a quantitative point of departure to be refined in future studies.

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PART II: RCRA FACILITIES

CHAPTER 1

INTRODUCTION

When introduced into the environment, the solid and hazardous wastes regulated under the Resource Conservation and Recovery Act (RCRA) and managed at RCRA facilities can threaten both human health and ecological receptors. Although the regulations and policies developed and implemented under RCRA are intended to minimize such threats to human health and the environment, the protection of human receptors has been the main focus of the RCRA program. Because of this emphasis on human receptors, resource commitments for characterizing the extent of ecological threats at RCRA sites, developing ecological assessment methods, and addressing issues associated with the management of ecorisk information have been limited.

To help correct this imbalance, OPA has initiated a study of three broad topics: 1) the nature and extent of ecological threats at RCRA sites; 2) the ecological assessment methods that have been or could be used in the RCRA program; and 3) past and potential future ecorisk management decisions. This report addresses the first topic and has three main purposes:

- To document the nature and extent of ecological damages and risks from the management of RCRA wastes;
- To characterize, if possible, the types of management practices, environmental settings, and wastes posing the most significant ecological risks; and
- To evaluate whether ecological risks at RCRA facilities are adequately considered and controlled under the RCRA program.

This report includes data on the nature and extent of both actual, observed ecological impacts and predicted ecological impacts (i.e., risks) at RCRA facilities. The term ecological "threat" often is used in the report to refer to both observed and predicted impacts. Contamination of and adverse effects to biota are examined, as is media-specific contamination that may pose a risk to biota. The report primarily focuses on baseline ecological threats that exist(ed) before response actions have been (were) taken, not the ecological problems caused by a response action or the residual threats after a response.

This report addresses most of the major RCRA program areas which regulate or encompass activities that are expected to pose significant ecological risks. Specifically, we address ecological concerns of Subtitle C, municipal and industrial Subtitle D, mining and beneficiation, oil and gas, coal utility, and smelting and refining facilities. Although Subtitle I (underground storage tank) facilities may also pose ecological threats, they were not considered in this analysis.

The information available to characterize the ecological threats posed by each of the RCRA program areas varies greatly. OPA focused principally on Subtitle C facilities, because documentation for these facilities is both more comprehensive and more readily available through EPA Headquarters reports and Regional facility files.

1.1 Major Limitations and Caveats of this Assessment

This report is limited in scope by the availability of relevant studies for analysis, the lack of ecological risk information for most types of facilities, the representativeness of the data collected and analyzed for this report, and the relative youth of much of the RCRA program and its associated data collection activities. We nevertheless believe that the types of ecological impacts associated with RCRA facilities are accurately depicted in this report. OPA, therefore, intends this report to represent the first known attempt at summarizing the available information concerning these impacts.

The primary factor limiting this analysis is the paucity of information relevant to ecological threats at RCRA facilities, including the limited number and scope of past analyses of this issue, and the lack of data describing specific ecological impacts. The findings of this report are based on original material gathered specifically for this analysis as well as previously conducted national modeling studies and damage case compilations.

The national studies and previous damage compilations have been conducted primarily for purposes other than assessing ecological threats. Therefore, extrapolating the findings and data from these previous studies to draw conclusions requires assumptions concerning their applicability to this analysis, as discussed in subsequent sections.

Another data limitation problem exists with respect to facility-specific information on ecological impacts. For example, Subtitle D and special waste facility documentation is, for the most part, held in the States, and is not readily accessible for compilation. Therefore, this analysis has relied on secondary sources to describe a limited number of damage cases.

The limited availability of data characterizing each of the RCRA program areas results in disproportionate attention to specific programs, geographic locations, and facility types for which data are available. This presents difficulties for comparisons of ecological effects among different RCRA programs and the national extent of the problems identified.

Many of the limitations mentioned above result directly from the RCRA program's relative lack of emphasis on remedial investigation activities. This emphasis is changing, however, as the corrective action program for solid waste management units at hazardous waste facilities is implemented under RCRA 3004(u) and 3008(h). The RCRA Facility Assessments (RFAs) and RCRA Facility Investigations (RFIs) to be conducted under this program may, if properly oriented, serve to gather information on the types of releases and ecological effects associated with RCRA Subtitle C hazardous waste facilities.

1.2 Guide to the Remainder of Part II of the Report

The remainder of this report is organized into four chapters. In Chapter 2, we briefly present the approach used to conduct this analysis, including a discussion of the sources of information and methods of data collection and analysis. In Chapter 3, we discuss the results of our analysis. Finally, Chapter 4 summarizes our findings concerning ecological impacts at RCRA facilities and presents conclusions about the types of RCRA facilities posing ecological threats. Summaries of the data collected for this analysis are included in appendices.

CHAPTER 2

APPROACH

OPA directed its efforts toward gathering information from two primary sources. First, we collected and reviewed program analysis and regulatory development documents that discuss environmental effects at RCRA facilities. Second, we contacted RCRA professionals familiar with specific facilities to identify sites where ecological threats had been characterized and used in the RCRA decision-making process. We also collected and summarized documentation for facilities identified by these personnel.

2.1 Program Analysis and Regulatory Development Documentation

Our review of program analysis and regulatory support documentation involved the examination of Regulatory Impact Analyses (RIAs), Reports to Congress, comparative risk analyses, and program-specific background information documents pertaining to the following six RCRA program areas:

- Subtitle C (hazardous waste);
- Subtitle D (municipal and industrial solid waste);
- Special Wastes --
  - Mining Waste,
  - Oil and Gas Waste,
  - Coal Utility Waste, and
  - Smelting and Refining Waste.

For each RCRA area considered in this analysis, OPA examined two types of available documentation. First, we sought data on the national extent of the ecological threats posed by solid and hazardous waste management. Typically, these data included the total number of facilities/sites affected versus the number existing, total amounts of waste produced, and/or the proximity of a typical facility to endangered or sensitive species habitats. Next, we sought information regarding the nature of potential or existing ecological threats at each type of facility. For most RCRA areas, this information was available through case study analyses contained in RIAs, Reports to Congress, and other studies.

Our analysis did not include an examination of threats posed by RCRA Subtitle I (Underground Storage Tanks (USTs)) facilities. In addition, ecological threats from waste management activities regulated under other statutes, such as the Toxic Substances Control Act (TSCA) or the Clean Water Act (CWA), are not discussed in this analysis. For example, in one previous comparative risk analysis, ocean dumping is considered to pose a significant (if not the greatest) threat to marine ecosystems. Since ocean dumping is regulated under the Marine Protection, Research, and Sanctuaries Act of 1972, however, and not RCRA, the associated ecological threats from this source are not within the scope of this analysis. Furthermore, we did not attempt to summarize information for land disposal facilities that are now being addressed under the Superfund program. Such facilities are described in Part I of this report.

2.2 Interviews and Meetings with RCRA Professionals

As a first step in our search for information describing the nature and extent of ecological threats from RCRA sites, we implemented a telephone interview survey with RCRA professionals in the EPA Regions and States. We contacted appropriate people at EPA headquarters, all ten EPA Regional offices, and a number of State agencies from each Region. In addition to our phone interview survey, we also made visits to RCRA offices in EPA Regions 3 and 4, and Georgia's Department of Natural Resources. During our office visits, we collected site-specific file information and met with Regional and State personnel to discus ecological threat information and methodologies used in the RCRA program. A list of all Regional and State contacts is provided in Appendix D, along with a summary of the telephone interviews.

The information requested through the interview process focused on two areas: 1) obtaining documentation on facilities with known or suspected ecological damages, and 2) assessment of the role of ecological threat information in the RCRA program. Interviewees were asked to identify and provide documentation on RCRA sites with known or suspected ecological threats.

Aside from obtaining site-specific documentation, the interviews were aimed at assessing the general use of ecological threat information in the RCRA program. The adequacy of current ecological risk methodologies was discussed along with possible means of improving the methods. The interviewees were also asked to describe how ecological threat information was being used in RCRA decision making and to identify the main barriers to the use of this information. The conclusions drawn from these interviews are summarized in Chapter 3.

2.3 Case Study Analysis

Our case study analysis of RCRA program areas is based on two sources of information: 1) a first-hand review of original RCRA facility documentation (Subtitle C only), and 2) a second-hand review of damage cases described in available program analysis and regulatory development documentation. Both of these sources, and our approach to their analysis, are described below.

2.3.1 Subtitle C Case Studies

Using the information collected through phone interviews and meetings with personnel in Regions 3 and 4, we developed case studies of RCRA Subtitle C facilities for which ecological threat information has been collected and used to support permitting or corrective action activities. Although the RCRA personnel we contacted identified 52 facilities that may have been evaluated for ecological damage, much of this information is anecdotal. We were able to obtain useful documentation for 16 Subtitle C facilities at the time this report was prepared.

The case study descriptions present a synopsis of the facility characteristics relevant to this analysis, including:

- a description of the facility's primary function, waste management units, and environmental setting;
- a brief summary of the facility's status in the RCRA program;
- observed or potential environmental threat characteristics, including environmental media contaminated, biota contaminated, hazardous constituents involved, and release and exposure pathways;
- observed or potential ecological impacts related to facility operations; and
- a summary of the manner in which ecological information has been, or may be, used at the facility.

The information summarized in these case studies supports our assessment of the nature of observed ecological impacts and the waste management practices, environmental settings, and types of wastes most commonly associated with ecological impacts. The Subtitle C case study information is presented in summary form in Chapter 3, and documented in full in Appendix E.

2.3.2 Damage Cases from Reports to Congress and Regulatory Impact Analyses

The damage cases prepared for Reports to Congress and Regulatory Impact Analyses provide another source of site-specific information. We reviewed the program analysis and regulatory development documents described above and compiled the information presented as damage cases for analysis as case studies. To the extent permitted by the level of detail provided in the damage cases, we have characterized the types of ecological damages observed, the waste management practices involved, ecological settings, and the waste characteristics in order to assess the nature of ecological threats arising from RCRA facilities. Damage cases involving waste management at Subtitle C, municipal Subtitle D, mining, oil and gas, coal utility, and smelting and refining facilities are presented as case studies in Chapter 3.

CHAPTER 3

RESULTS: NATURE AND EXTENT OF ECOLOGICAL THREATS AT RCRA FACILITIES

In this chapter, we present the results of our investigation of the nature and extent of ecological threats at RCRA facilities. This discussion is organized around the major areas of RCRA regulation: Subtitle C; Subtitle D; and the large volume wastes from mining and beneficiation, oil and gas production and development, coal utilities, and smelting and refining. For each major RCRA program area, we summarize the available information relevant to ecological impacts, discuss the extent of ecological threats, discuss the nature of ecological threats (as evidenced through case studies and general descriptive information available in the program analysis and regulatory development documentation), and summarize the characteristics of the ecological threats presented by facilities in the RCRA program.

For this analysis, the "nature" of ecological threats refers principally to the type and severity of damages observed (e.g., fish kills, altered community structure), and the typical release/exposure pathways. The "extent" of ecological threats indicates the breadth and magnitude of potential ecological risks in terms of facility size, population of potential and/or actual receptors, location, waste quantities generated, and number of releases experienced and/or health-based levels exceeded.

3.1 Subtitle C Facilities

3.1.1 Summary of Available Information

We assessed the broad ecological threats presented by RCRA Subtitle C (hazardous waste) activities based on an examination of the following documents:

- Corrective Action RIA;
- Wetlands (Location Standards) Background Information Document/RIA;
- Floodplains (Location Standards) Background Information Document/RIA;
- Small Quantity Generator (SQG) RIA;
- Solvent Wastes RIA; and
- Information collected through interviews with RCRA professionals and searches of Regional and State files.

Although none of these documents entirely address the nature and extent of ecological threats at Subtitle C facilities, the integration of data from these sources yields a relatively comprehensive analysis.

The nature of ecological threats posed by Subtitle C facilities is characterized by the damage cases presented in the Wetlands and Floodplains (Location Standards) Background Information Documents/RIA and the case studies developed from site-specific documentation identified through contact with RCRA professionals.

3.1.2 Extent of SUBTITLE C Ecological Threats

The projected number of hazardous waste treatment, storage, and disposal facilities (TSDFs) expected to require cleanup was estimated in the RIA for the RCRA Corrective Action rule. According to the RIA, 3,487 of an estimated 5,661 (TSDFs) located in the U.S. (62 percent) are expected to require a RCRA Facility Investigation (RFI; i.e., have experienced some level of hazardous waste release to the environment). Of all 5,661 facilities, 17 percent are expected to require cleanup of surface waters, 34 percent will require soil cleanup, 30 percent will require ground-water cleanup, and 7 percent of the facilities are expected to require cleanup of releases to air. These estimates are based, in part, on reports of 1,248 release incidents from land disposal facilities in the last three years. Of these 1,248 incidents, 590 cases involved releases to ground water, 537 reported surface water contamination, 518 reported releases to soil, and 118 cases involved releases to air. Many of the release incidents involved contamination of more than one medium. Although these data give some indication of the extent of releases from Subtitle C facilities, they do not provide a direct indication of the ecological damage caused by the releases. Nonetheless, the data do indicate a need to assess ecological threats in Subtitle C facility investigations.

Through our telephone interviews and meetings in Regional and State offices, we gathered information on RCRA professionals' general impressions of the ecological threat posed by Subtitle C facilities. A detailed summary of the results of the Regional and State interviews is presented in Appendix D. The more salient points raised by the RCRA personnel are as follows:

- Many RCRA facilities may pose ecological threats, but due to the relative youth of the RCRA program and the relative lack of attention given to ecological risks, there is little available documentation to support any assessments or conclusions about the nature and extent of ecological threats presented by RCRA facilities.

- There has been little emphasis placed on collecting ecological information either at the program analysis or site-specific assessment level. Therefore, when ecological information has been collected, it may not be truly representative of the nature and extent of the problem.

- Interviewees from six Regions stated that ecological threats at RCRA facilities are given inadequate consideration. This inadequacy was attributed to a lack of appropriate assessment methods, a lack of guidance, the impression that ecological concerns are "too big to deal with," program emphasis on human health, and an inability to address terrestrial threats. Only one interviewee suggested that current considerations of ecological threats in RCRA were adequate.

- The impact of contaminated ground water on wildlife in hydrologically connected streams has not been extensively evaluated, but may be a widespread problem at RCRA sites.
- Data collected through the corrective action RFA/RFI process may provide a much greater indication of the nature and extent of the ecological risk problem.
- Permitted and new Subtitle C facilities should not pose a significant ecological threat due to the strict technical permitting standards which prevent releases.

The main conclusion drawn from these interviews is that most Regional and State personnel believe that ecological impacts at RCRA Subtitle C facilities may be widespread, but that sufficient data are not yet available to accurately characterize the scope of the problem. The following section provides greater detail concerning the nature of the threat at RCRA Subtitle C facilities with known ecological impacts.

3.1.3 Nature of Subtitle C Ecological Threats

The case studies of RCRA Subtitle C facilities illustrate, by actual examples of ecological impacts and considerations, the nature of the ecological threats at these facilities. These case studies are based on information from two sources: Subtitle C facility files and the damage cases in the two Location Standards Background Information Documents/RIA.

Subtitle C Case Studies

Case studies for 16 Subtitle C facilities where ecological threats have been assessed or where permitting or corrective action decisions rely on information about ecological threats have been developed. Exhibit II-1 presents brief descriptions of these 16 facilities. The case studies are listed in order of geographic location (i.e., from Region 1 to Region 10), and alphabetically within each Region. Appendix E to this report presents more detailed, one-page discussions of these case studies.

As can be seen in Exhibit II-1, nine of the 16 cases discuss facilities located in EPA Regions 3 and 4. This geographic distribution reflects variations in the level of effort in requesting, and success in obtaining, ecological threat documentation from the Regions rather than the actual distribution of sites presenting ecological threats in the U.S.

Location Standards Damage Cases

Of eight Subtitle C documents examined, only the two Location Standards Background Documents/RIAs contain sample cases of hazardous waste releases from Subtitle C (or comparable CERCLA) facilities. The presentation of these case studies in the RIA was intended to provide background information for floodplain and wetland land disposal restrictions. Therefore, the damage cases emphasize impacts to surface waters and wetlands and not terrestrial ecological effects. All of the eight case studies involve releases to

EXHIBIT II - 1

RCRA ECORISK SUBTITLE C CASE STUDIES

Facility	Facility/Site Description	RCRA Status	Nature of Environmental Threat	Ecological Impacts and Use of Ecological Information
Saco Defense, Inc. Saco, Maine Region 1	Weapons manufacturing facility with 12 SWMUs: 6 landfills/lagoons, 5 waste storage areas, 1 wastewater treatment plant.	Under a consent order to conduct an RFI.	Potential ground-water, soil, surface water and air contamination by chlorinated ethanes and ethenes. Pathway is thought to be by seepage from landfills and lagoons to ground water, overland flow to surface water, and direct discharge to surface waters.	Proposed identification of sensitive areas and nearby wildlife in RFI.
Wyman-Gordon North Grafton, Mass. Region 1	The waste management area of concern is a treatment lagoon. Nearby wetlands receive ground water downgradient from the lagoon.	ACL petition included in Part B permit application.	Wetlands, surface water, and ground-water contamination by arsenic, chromium, nickel, and high pH. Pathway of concern is a ground-water seep into a wetland. Up to 3.5 acres of the wetland area are contaminated.	Wetlands assessment demonstrates decreased species diversity, lower productivity, and altered life cycle in affected wetland area. Biological assessment of stream demonstrates that it is healthy.
Allied Chemical Baltimore Works Baltimore, Maryland Region 3	Chrome plating facility storing chrome ore tailings. Located in estuarine environment near Baltimore's inner harbor.	Negotiating corrective measure selection and design.	Surface water, sediments, ground water, and soil contaminated with chromium. Releases occur via wastewater discharge and fill in and around harbor using chromite ore residue.	Increased body burden in blue crabs and other benthic invertebrates. Low species diversity in areas of high chromium concentrations. Potential chronic effects on aquatic life from concentrations above threshold criteria.
Defense General Supply Center Chesterfield, Virginia Region 3	640-acre storage facility with landfills, open storage areas, a fire training area, and a vehicle maintenance area. Two creeks, a wetland, a pond, and an elk herd in the vicinity of the waste management areas. Possible habitat for 4 endangered species.	Requesting HSWA permit modification for construction in area of contaminated soil. Facility undergoing CERCLA field investigations as well.	Soil, ground-water, and surface water contamination by metals, chlorinated organics, and acetone. Releases by spills and subsequent transport to ground water and surface water.	Proposed wetlands assessment and toxicity testing. Assumed use of proposed study will be to assess needs for corrective action.
Rohm and Haas Delaware Valley, Inc. Briston, Pennsylvania Region 3	Chemical manufacturing plant with a landfill and storage area. Site borders the tidally influenced Delaware River and encompasses 120 acres of open woodland and marsh land.	Subpart S corrective action.	Soil, ground water, surface water, and air contaminated by chlorinated organics and benzene. Potential release pathway is via leaching from landfill, surface runoff, and direct discharge.	No ecological assessment documentation available.
Kennedy Space Center Florida Region 4	Container storage facility. Adjacent wildlife refuge is the proposed location for an air stripper to treat ground water.	Operating under a corrective action order. Proposed corrective action developed on a voluntary basis.	Ground-water contamination by VOCs. Potential release and exposure pathway is via the proposed air stripping operation.	Potential exposure of wildlife to airborne contaminants. Potential effects have not been studied, but the issue has been discussed at recent meetings between EPA, DOI, and Kennedy Space Center.

EXHIBIT II - 1 (CONTINUED)

RCRA ECORISK SUBTITLE C CASE STUDIES

Facility	Facility/Site Description	RCRA Status	Nature of Environmental Threat	Ecological Impacts and Use of Ecological Information
Monroe Auto Equipment Plant Hartwell, Georgia Region 4	Auto equipment manufacturer landfilling sludge on-site. Other than a recreational fishing pond near the site, no other information on the ecological character of the site is available.	Undertaking corrective action, comparable to RCRA Subpart S, under supervision of the State of Georgia.	Soil, ground water, and surface water are contaminated with chlorinated alkanes and alkenes, aromatic hydrocarbons, and cadmium. Release is by leaching and runoff from the sludge landfill.	Toxicity criteria are not exceeded for sensitive plant and fish species. No degradation of biota observed, consequently no additional remedial action was undertaken.
Pratt and Whitney West Palm Beach, Florida Region 4	7,000-acre facility with 1 landfill, 4 burn pits, a recycling center, 2 waste piles, and 3 incinerators among other storage areas and treatment units.	Under a corrective action consent agreement a workplan for conducting an RFA has been submitted. Part B permit application deficiencies have been outlined.	Soils and canal sediments are contaminated with PCBs, solvents, acid wastes, heavy metals, and VOCs. Release is via spills, leaks, leaching, discharge, dumping, and exhaust.	No ecological assessment documentation available.
Southern Dye Co. (SODYECO) North Carolina Region 4	Chemical manufacturing plant with surface impoundments and landfill cells. The ground water below the site is hydrologically connected to the Catawba River.	Denied ACLs.	Ground water and surface water contaminated with metals, chlorinated organics, aromatic hydrocarbons, and pesticides. Contaminants released from surface impoundments through seepage to ground water.	Concentrations are above background but below threshold criteria. Low body burden of pollutants in catfish. ACL denied based on improper characterization of hydrogeology.
Southern Wood Piedmont Co. Baldwin, Florida Region 4	Wood treatment plant adjacent to tributaries of Baldwin Bay and wetlands areas.	ACL petition approved. Ongoing investigations to develop workplan prior to issuance of a HSWA permit.	Ground water, surface water, and sediment contaminated with arsenic, chromium, and a variety of aromatic contaminants. Release is via seepage from waste management pits to ground water and subsequent migration to surface water.	Toxicity of ground water measured. Water downgradient from the contamination source is somewhat toxic, but not as toxic as an upgradient "control" sample.
Union Carbide Agricultural Products Co., Inc. Woodbine, Georgia Region 4	Chemical formulation and manufacturing facility with a 20-acre landfill. Estuarine wetlands and a commercial oyster bed are nearby.	ACL petition (denied).	Ground water, surface water, and soil contaminated with metals, chlorinated organics, aromatics, and pesticides. Release via leaching from landfill and migration to surface water.	100% oyster mortality in the vicinity of the site. (Not conclusively linked to the site.) Potential exposures to a variety of animal species may cause acute and chronic effects. ACL petition denied on basis of undemonstrated protection of aquatic life.

EXHIBIT II - 1 (CONTINUED)

RCRA ECORISK SUBTITLE C CASE STUDIES

Facility	Facility/Site Description	RCRA Status	Nature of Environmental Threat	Ecological Impacts and Use of Ecological Information
Koppers Co., Incorporated Superior, Wisconsin Region 5	112-acre wood treating facility with a spray irrigation field, surface impoundments, ponds, and a drum storage area.	RFA has been completed and recommends certain areas and SWMUs for closer inspection in an RFI.	On-site and nearby off-site soils are contaminated from wood treating operations. Creek also contaminated from wastewater outfall.	One area of very sparse vegetation.
International Paper Joplin Treated Wood Products Plant Joplin, Missouri Region 7	Wood treatment facility with ponds, surface impoundments, and landfills. Silver Creek, near the facility, receives ground water from below the site.	Submitted a proposal for ACLs.	Ground water and surface water may be contaminated with creosote compounds, barium, beryllium, nickel, copper, vanadium, and zinc.	EPA denied/revised some ACLs to incorporate protection of aquatic life.
National Industrial Environmental Services (NIES) Furley, Kansas Region 7	80-acre hazardous waste treatment and disposal facility with treatment ponds, evaporation ponds, and land disposal cells. Prairie Creek flows nearby and there are several ponds near the facility. Ground water flows to springs of Prairie Creek.	Consent agreement and order requires NIES to establish ACLs.	Surface water and ground water contaminated with VOCs, beryllium, chromium (VI), cadmium, mercury, and phthalates. Release is via leaching to ground water and transport to surface water through solution pathways.	ACLs for 17 of 35 constituents are based on aquatic life protection criteria.
IRECO Chemicals Tooele County, Utah Region 8	Explosives testing and disposal area in quarry. Remote location that is a known breeding and wintering area for golden eagles, great horned owls, prairie falcons, red-tailed hawks, and ferruginous hawks.	Applied for RCRA permit. Subject to a compliance order until standards can be set for operation of this type of facility.	Atmospheric disturbance caused by detonation of waste explosives.	U.S. Fish and Wildlife study found successful raptor breeding, nesting, and fledging in the vicinity of the detonation area. Possible displacement of nesting in the quarry.
ARCO Prudhoe Bay-Eastern Operating Area Prudhoe Bay, Alaska Region 10	Oil exploration, production, and development site on the tundra of Alaska's North Slope with landfills, surface impoundments, container storage areas, tanks, waste piles, a recycling unit, and incinerators.	RFA completed with recommendations for RFIs at reserve pits and some other pits at this site.	Surface water, soil, and tundra vegetation of the area potentially contaminated by oily debris and drilling muds containing arsenic, barium, cadmium, chromium, lead, nickel, benzene, toluene, naphthalene, and fluoranthrene. Release is by direct discharge to the tundra, road and gravel pad application of waste liquids, and seepage from pits.	Potential ecological effects include bioaccumulation and toxicity of hazardous constituents. RFA provided no assessment of ecological impacts.

wetlands and/or other surface water, resulting in potential, if not documented, aquatic ecological effects.

Three case studies describe damages from facilities situated within 100-year floodplains. In each case, severe flooding and surface water releases of many types of hazardous constituents resulted in ecological effects such as crab and fish kills, vegetation destruction, and chronic exposures of plant and aquatic species.

Similar effects were noted in five wetlands damage cases, where releases included direct discharges such as the dumping of battery acids to wetland waters from a lead recycling facility, and indirect discharges such as leaching to wetlands from PCB-contaminated sludges stored in unlined pits. Significant ecological impacts may also have occurred at a landfill site due to leaching of hazardous constituents just upstream of a 1,200-acre national wildlife refuge.

Actual Damages

Of the 16 Subtitle C cases developed for this analysis, actual damages were reported for eight sites. Seven of the eight Location Standards damage cases present at least limited information on observed ecological effects. A variety of ecological impacts were identified at these 15 case study sites. Impacts to wetlands, aquatic life (including fish and benthic and other invertebrates) and terrestrial wildlife were reported in nine, 14, and one case(s), respectively. The most commonly observed ecological impacts at the case study facilities include mortality (5 cases), decreased species richness and diversity (5 cases), bioaccumulation of toxics (3 cases), decreased productivity (2 cases), increased contaminant body burden (2 cases), habitat alteration (1 case), deformity (1 case), stunted growth (1 case), and life cycle alteration (1 case).

Potential Threats

The other eight Subtitle C case studies developed for this report contained information on potential ecological threats. Additional studies have been initiated, in some instances, to assess these potential threats. Potential chronic and acute effects have been postulated at four and five facilities, respectively. The potential for bioaccumulation (2 cases), direct effects (1 case), and contamination of a sensitive area (1 case) have also been identified. In addition, the cases refer to two ongoing studies of species diversity and three ongoing bioassay analyses for toxicity.

3.1.4 Characteristics of Subtitle C Facilities Posing a Threat

The case studies described above illustrate the variety of facility types, waste management practices, environmental settings, and waste types associated with ecological threats at RCRA Subtitle C facilities. Eight of the 16 Subtitle C facility case studies developed for this report provide information on the nature of observed ecological threats. The other eight cases demonstrate how potential ecological threats can introduce special ecological considerations to permitting and corrective action decision making.

In the following discussions of facility type, setting, and waste characteristics, we consider all 16 of the general Subtitle C facility case studies, as well as the eight damage cases presented in the Location Standards Background Information Documents/RIA, in order to assess characteristics important in determining the ecological threat potential of Subtitle C facilities.

Facility Types

Of the 24 Subtitle C facilities identified as posing ecological threats, 13 are primarily waste treatment, storage, or disposal facilities (TSDFs). The remaining 11 cases involve waste management units at manufacturing facilities. These manufacturing operations include three wood treatment plants, three chemical manufacturing plants, and five plants that produce weapons, auto equipment, chrome-plated products, and unknown products.

The 16 case study facilities for which original documentation was obtained (via Regional visits and telephone contacts) encompass a wide range of RCRA Subtitle C program situations. Six facilities have included ecological criteria in petitions for alternate concentration limits (ACLs). Four cases arise from some consideration of ecological threats in RFAs or RFIs, and two others are currently undertaking or negotiating Subpart S corrective action steps outside the RFA/RFI process to mitigate ecological threats. One case study site became an ecological concern because of potential ecological impacts related to its voluntarily proposed corrective measure. Ecological threats at one case study facility were investigated under CERCLA, but are now being addressed under RCRA authority. One facility has had an ecological study performed as part of permitting, and another is proposing ecological assessments and bioassays coinciding with a request for a permit modification. The RCRA program status is not available for the eight Location Standards damage cases.

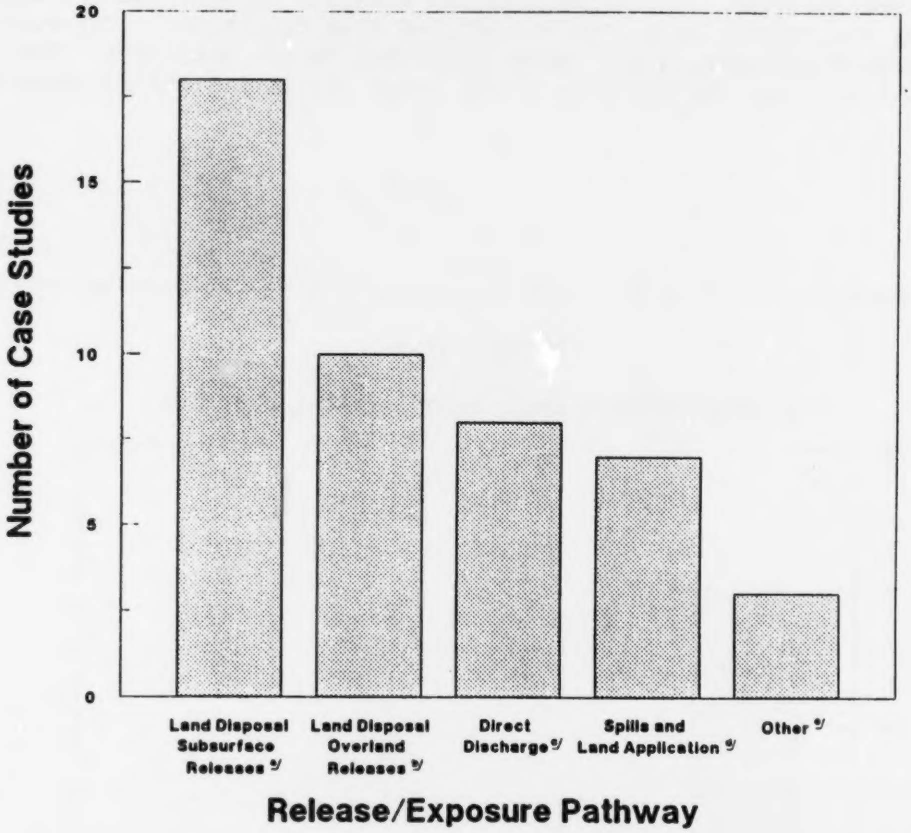
Waste Management Practices

Landfills and surface impoundments (including treatment and storage ponds, pits, and lagoons) are the predominant types of waste management units at the case study facilities. Container storage areas are implicated as sources of ecological threats in a few cases, as are wastewater treatment discharges and waste piles.

The predominant release/exposure pathway from these management practices is by subsurface leaching from a lagoon, pit, or landfill to ground water with subsequent migration to surface water (18 cases). Overland flow to surface waters occurs in 10 cases as a result of surface impoundment releases and is an important exposure pathway, particularly for the cases illustrated in the Location Standards documents. Another release/exposure pathway of importance, occurring in 8 cases, is the direct discharge of wastes and wastewater to surface waters. Finally, the leaching and migration of spilled or land applied waste was implicated in seven of the 24 Subtitle C damage cases. The release/exposure pathways observed in the case studies are summarized in Exhibit II-2.

EXHIBIT II-2

SUBTITLE C CASE STUDY RELEASE/EXPOSURE PATHWAYS



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a/ Land disposal subsurface releases consist of leaching of wastes or constituents from landfills, lagoons, pits, or ponds with subsequent migration to ecological receptors.

b/ Land disposal overland releases consist of runoff from landfills, lagoons, pits, or ponds to ecological receptors.

c/ Direct discharge of wastes or wastewaters to ecosystems (usually surface water).

d/ Spills and land application releases consist of migration of spilled or land applied wastes or constituents to ecological receptors.

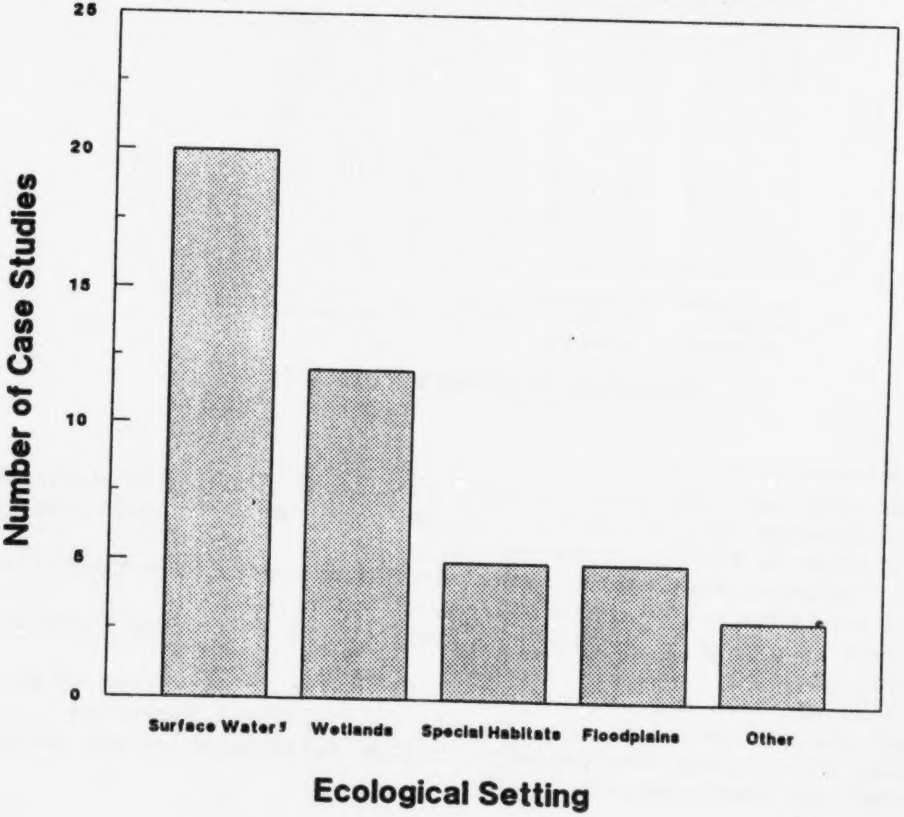
e/ Other release/exposure pathways include volatilization and no release of hazardous constituents.

Environmental Settings

The Subtitle C damage case studies are predominantly located near surface waters. At 20 of the 24 facilities, nearby surface waters are identified as exposure points of potential concern. Twelve facilities are either located in, or are near, wetlands. Special habitats, such as endangered and protected species habitat and wildlife refuges, and floodplain environments are identified in the vicinity of five facilities. Information on the environmental setting for three facilities is not available. The environmental settings for Subtitle C case study facilities are summarized in Exhibit II-3.

EXHIBIT II-3

SUBTITLE C CASE STUDY ENVIRONMENTAL SETTINGS



a/ The ecological settings listed are those in the vicinity of the case study facilities.

Wastes of Concern

The waste contaminants of concern at Subtitle C facilities are quite varied. Organic contaminants posing ecological threats at these facilities include aromatic hydrocarbons and substituted hydrocarbons, chlorinated alkanes and alkenes, other volatile organic compounds, polyaromatic hydrocarbons, and creosote compounds. Metals, especially chromium, cadmium, arsenic, mercury, beryllium, barium, nickel, and lead, are quite commonly implicated as contaminants of concern as well. PCBs, pesticides, acids and alkalis are also identified as contaminants of concern. Information regarding constituent concentrations and waste volumes present at Subtitle C facilities was incomplete and highly variable among the case studies and regulatory development documentation and consequently is not included in this analysis.

3.2 Subtitle D Facilities

3.2.1 Summary of Available Information

The ecological threats resulting from RCRA Subtitle D (Solid Waste) facilities were assessed based on an examination of the following documents:

- Subtitle D Criteria for Municipal Solid Waste Landfills RIA;
- OSWER Ecological Evaluation of a Municipal Landfill in the Superfund Program;
- OPA, OPPE Unfinished Business Report; and
- EPA Region 1 Draft Comparative Risk Assessment.

These four documents provide little data on the actual ecological threats at existing RCRA Subtitle D facilities. Resource damages (i.e., the national extent of ecological threats) attributable to Subtitle D facilities are measured only with regard to the estimated costs of providing drinking water to users whose supply is contaminated from municipal solid waste landfills (MSWLFs). Data were available, however, depicting a predominance of releases from facilities regulated under Subtitle D. Though the RIA contains a discussion of the nature of ecological threats at these facilities, we identified only one damage case applicable for use in this analysis.

3.2.2 Extent of Subtitle D Ecological Threats

An estimated 6,479 MSWLFs were in use as of May 1987. Thirteen percent (842) of the MSWLFs are located within designated 100-year floodplains, and six percent (388) are situated in wetland areas. The Subtitle D Criteria for MSWLFs RIA estimated that ground-water contamination has occurred at 71 percent (4,600) of all MSWLFs. No specific data is available as to the extent of contamination from MSWLFs to soil, surface water, or air.

Of 83,794 industrial facilities (i.e., those facilities managing less than 50 percent household or commercial wastes) regulated under Subtitle D, hazardous release incidents have occurred at an estimated 1,168 facilities. In addition, 111 Subtitle D municipal combustors burn greater than 6 million tons of waste annually. Emissions from these incinerators and combustors have not been investigated on a national basis with regard to ecological risks. As with Subtitle C facilities, the projected incidence of hazardous releases from Subtitle D facilities does not provide a direct indication of ecological damage, but it does indicate the need to assess ecological threats in Subtitle D facility evaluations.

3.2.3 Nature of Subtitle D Ecological Threats

From the limited documentation available describing Subtitle D ecological threats, we identified only one damage case study illustrating the nature of these threats. This study involved leaching from a 300-acre MSWLF to on-site lakes and an adjacent sensitive wetlands area separating the site from a coastal embayment 2,000 feet away. Releases of ammonia, arsenic, barium, vinyl chloride, heavy metals, pesticides, and volatile organics affected on-site soils, lakes, and nearby wetlands and estuarine systems. Though many uncertainties in the risk assessment process precluded a quantitative risk estimate, projected ecological damages from contaminant releases included toxic effects (e.g., impaired health and reproduction) to freshwater and estuarine fish and macroinvertebrates.

The damage case study described above and the discussion of MSWLFs contained in the RIA do not provide adequate information to present any detailed analysis of the ecological threat characteristics of Subtitle D facilities in terms of observed ecological damages, waste management practices, environmental settings, or primary wastes of concern at these facilities.

3.3 Mining Waste

3.3.1 Summary of Available Information

The risks posed by mining sites were assessed based on an examination of the following documents:

- Report to Congress: Wastes from the Extraction and Beneficiation of Metallic Ores, Phosphate Rock, Asbestos, Overburden from Uranium Mining, and Oil Shale;
- OSW Draft Risk Screening Analysis of Mining Waste;
- SCS Summary of Environmental Incidents from the Disposal of Mining Waste.

From these sources, we obtained information on the nature of mining waste ecological threats, including damage case studies describing typical contamination scenarios, mining waste contaminants of concern, release mechanisms, and documented effects on nearby ecosystems. With regard to the national extent of these threats, we determined the number of active mining sites and the proximity of these sites to designated sensitive environmental areas. It should be pointed out, however, that these sources provide only case studies of mining waste sites. They do not provide a general overview of the extent of ecological threats at mining waste facilities and should not be interpreted to be comprehensive or entirely representative of all mining facilities. Furthermore, some of the ecological damage cases may have been caused by past mining waste management practices that are no longer followed.

3.3.2 Extent of Mining Waste Ecological Threats

The OSW risk screening analysis of mining waste identified 292 mines for evaluation. Of the 292 identified mine waste sites, 162 (59 percent) were known to be active or potentially active. Of the 162 active sites, 26 (16 percent) were located within five kilometers of an endangered or threatened species habitat. Of all 292 risk screen mines, 60 (23 percent) were located within the boundaries of a national forest. Phosphate mines may pose the most significant threat to sensitive areas; 58 percent were within five kilometers of threatened or endangered species habitat, and 78 percent were within five kilometers of wetlands. Although these data provide an indication of the proximity of mining waste sites to sensitive areas, this information can only indicate the potential for impacts and does not provide a clear measure of ecological threat.

3.3.3 Nature of Mining Waste Ecological Threats

Based on 68 case studies documented in the SCS Summary of Environmental Incidents, OPA identified contaminant releases from 45 active mining waste sites that have resulted in threats to terrestrial and aquatic plant and animal species through soil, ground-water, and surface water exposure pathways. Exhibit II-4 presents the summaries of 10 of these 45 cases that best represent the nature of ecological threats at mining facilities.

Observed Ecological Damages

Adverse effects on non-human biota were reported in 41 (60 percent) of the 68 case studies. These effects ranged in magnitude from mere "stress on aquatic life," to inhibition of species reproductive capabilities, to acute exposures resulting in fish kills, to destruction of all aquatic life. Catastrophic events (e.g., holding pond dam failure and pipeline breaks) have resulted in extensive acute ecological damages, including large scale fish kills and population impairment and reduction for birds, benthos and other aquatic organisms. Other ecological damages observed include bioaccumulation of heavy metals in salmonids.

3.3.4 Characteristics of Mining Facilities Posing a Threat

Based on the damage case studies and discussion of mining waste sites contained in the SCS Summary of Environmental Incidents, we have summarized below the characteristics of mining waste management that pose ecological threats. We discuss mining facility types, waste management practices, environmental settings, and primary wastes of concern at these facilities.

Facility Types

Exhibit II-5 illustrates the distribution of mining waste case studies among various industry segments. Nearly half of the damage cases involve copper mining. Eighteen cases each involve the mining of silver and gold.

EXHIBIT II - 4

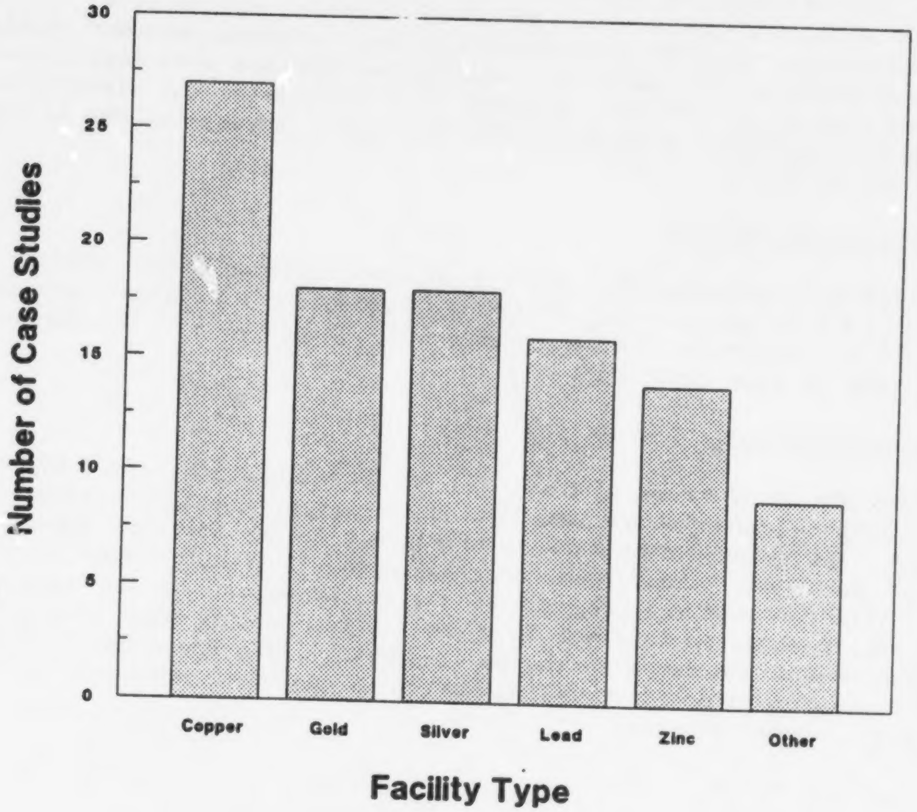
DAMAGE CASE STUDY INFORMATION AVAILABLE DESCRIBING ECOLOGICAL IMPACTS AT MINING WASTE SITES

Damage Case	Facility/Site Description	Characterization of Ecological Impacts
AZCB	An active open pit mine with copper leachate operations. Source of contamination from tailings pond.	Waste release from pond after heavy rains during the winter of 1978-1979. An adjacent creek was contaminated with metals and low pH. Aquatic and bird populations were impaired as a result of the contamination.
AZMM	An active copper mine and smelter with copper leachate operations. Main source of contamination from tailings pond.	448,000 gallons of leachate water released from tailing pond in a 24-hour period after heavy rains. Ninety-eight percent of aquatic life killed in an adjacent creek.
COUD	An active metals mine. Tailings ponds are likely contaminant source.	Leachate seepage from tailings pond and subsequent migration to surface water. River water quality degraded with high levels of copper, zinc, lead, mercury, and total suspended solids.
IDBN	An active open pit copper, aluminum, and cobalt mine and milling operation. Contaminant source from waste piles and tailings pond.	Tailings leachate contaminate surface water via runoff with copper, cobalt, iron, and sulfate. Adjacent creek sterile for 35 miles.
MOBU	An active lead and zinc mine with milling operations. Tailings pond and mine water are likely contaminant sources.	Discharge of tailings and mine water to surface water. Water quality degraded with metals and organics. Benthos communities reduced in a 3 mile stretch of an adjacent creek.
MOAC	An active lead, zinc and copper mine with milling operations. Main sources of contamination are tailings pond and mine water.	Release of tailings from holding pond after dam failure during heavy rains. Surface water contamination with lead, zinc, copper and cadmium. Heavy meals have accumulated in an adjacent lake.
MTUL	An active gold and silver mine with cyanide leachate and milling operations. Main contamination sources are tailings pond and leachate solution.	Failure of pond liner integrity permitted cyanide solution to leach from pond to ground water. Subsequent migration of cyanide leachate to surface water resulted in surface water quality degradation.
NVRA	An active gold mine and cyanide leaching operations. Cyanide stored in drums and an unlined holding pond are main sources of contamination.	15,000 gallons of leachate liquor released to ground water and surface water after dam failure. Improper disposal of cyanide barrels contributed to the contamination incident. Degradation of ground water and surface water has been observed as a result of the release.
NMWQ	Active open pit and underground molybdenum mines and milling operations. Tailings impoundments are main source of contamination.	Tailings pipeline breaks in 1977, 1979, 1980, and 1981 released concentrations of cadmium, chromium, copper, silver and zinc to surface water. Reduction in aquatic organisms and bioaccumulation in salamanders have been observed.
UTKC	An active copper mine with precipitation plant and concentrator operations. Contamination from tailings pond and hauling waste.	Tailings leachate and erosion caused degradation of adjacent creek with total suspended solids, copper and high concentrations of arsenic.

Source: Summary of Environmental Incidents from the Disposal of Mining Wastes. SCS Engineers, 1985.

EXHIBIT II-5

MINING WASTE CASE STUDY FACILITY TYPES



Sixteen of the 45 cases involve lead mining, and 14 of the cases involve zinc mining. Three damage cases are characterized as "hard rock" mining. Other mining industry segments identified among the damage case studies include cadmium, cobalt, barite, indium, molybdenum, and "metals."

Waste Management Practices

Mining waste management units associated with the damage cases are ponds (33 cases), waste piles (24 cases), and leach residue and waste rock dumps (14 cases). In one damage case discharge of wastewater from a treatment plant resulted in ecological threats, and in another direct discharge of wastes to surface water produced the threat.

In 26 of the 45 damage cases continuous, intermittent, or seasonal runoff from ponds, piles, or dumps to surface water provided the release/exposure pathway. In 18 damage cases, contaminants were released by continuous, intermittent, or seasonal seepage to ground water with subsequent migration to ecological receptors. In 12 of 45 cases, spills from catastrophic events, such as impoundment failure, produced releases resulting in ecological threats. In two cases, deliberate releases were implicated in the observed ecological threats. Exhibit II-6 illustrates the distribution of release/exposure pathways responsible for ecological threats at the mining facility case studies.

Environmental Setting

Limited data was available describing the locations of the mining facilities cited as experiencing observed or potential ecological impacts. However, all 45 facilities indicate damages to surface water. In one case, damage to soil is also indicated.

Wastes of Concern

As evident in the case studies, the predominant mining waste types causing ecological damages are tailings, over burden, leachate residue, and mine water. The primary contaminants of concern in the 68 cases include heavy metals such as copper, zinc, iron, and manganese. Seventy percent of all of the cases also reported the presence of silver, arsenic, cadmium, mercury, and lead. Acidic wastewater releases from these sites contain high levels of dissolved minerals and decrease the pH of streams. The frequency with which specific contaminants occur in mining wastes is dependent upon the industry sector (e.g., copper or zinc).

3.4 Oil and Gas Waste

3.4.1 Summary of Available Information

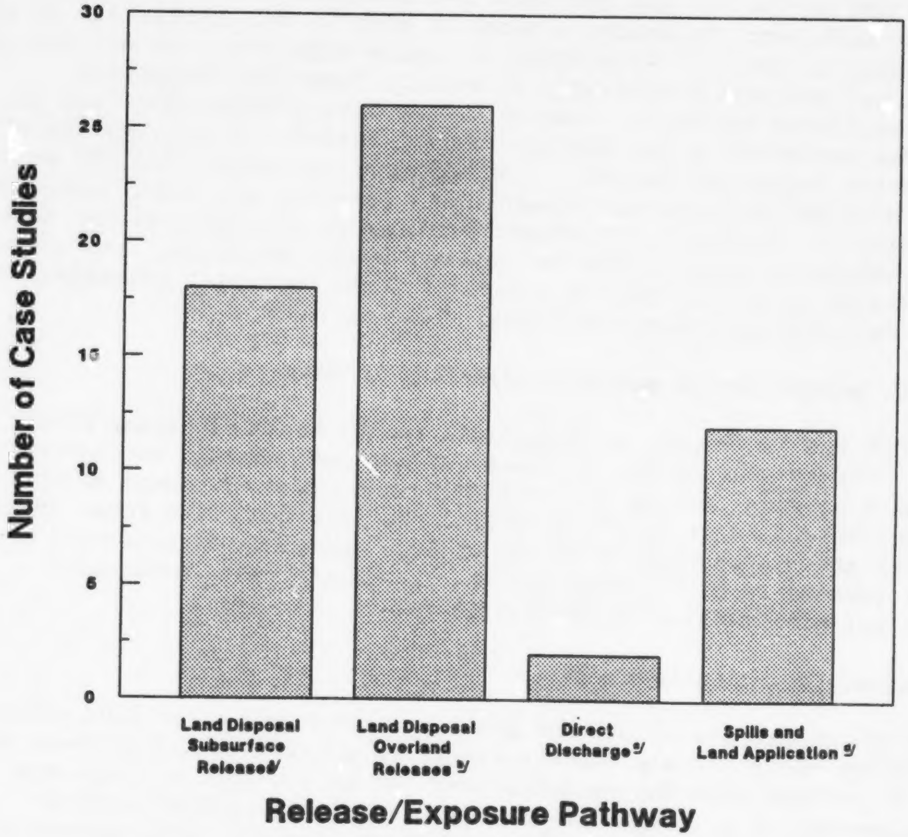
The ecological risks resulting from oil and gas waste management are well documented compared to many of the other RCRA program areas. For this analysis, we assessed these risks based on an examination of the following documents:

- Report to Congress: Management of Wastes from the Exploration, Development, and Production of Crude Oil, Natural Gas, and Geothermal Energy; and
- Ecological Impacts of Oil and Gas Waste Streams.

These sources contained information on the national extent of ecological threats posed by oil and gas wastes in terms of the quantities of wastes produced and the areal extent of resources potentially impacted. The nature of oil and gas ecological impacts was illustrated by damage case studies describing observed ecological damages, typical facility waste practices, environmental settings, and contaminants of concern. Our review of these case studies, however, is based only on the information presented in the Report to Congress, and therefore should not be interpreted to be in any way

EXHIBIT II-6

MINING WASTE CASE STUDY RELEASE/EXPOSURE PATHWAYS



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a/ Land disposal subsurface releases consist of leaching of wastes or constituents from landfills, lagoons, pits, or ponds with subsequent migration to ecological receptors.

b/ Land disposal overland releases consist of runoff from landfills, lagoons, pits, or ponds to ecological receptors.

c/ Direct discharge of wastes or wastewaters to ecosystems (usually surface water).

d/ Spills and land application consist of migration of spilled or land applied wastes or constituents to ecological receptors.

comprehensive or entirely representative of impacts from all oil and gas waste facilities.

3.4.2 Extent of Oil and Gas Ecological Threats

Oil and gas operations produce approximately 20.9 billion barrels of production waste, and 361 million barrels of drilling waste annually from roughly 835,000 active oil and gas wells nationwide. Approximately 9,000 oil spills occur each year, releasing a total of over 11 million barrels of oil. Of 190 counties in the U.S. identified as having high levels of oil and gas exploration and production activity, 13 contain Federally-designated critically sensitive habitats. Federal leases have granted 25 of the 191 million acres contained in the National Forest system (13 percent) for oil and gas exploration and/or production. Similarly, approximately 335,000 acres within the National Park system (roughly four percent) are under lease for oil and gas activity. Though little direct evidence is available on the actual extent of ecological effects from oil and gas waste operations, the large volume of wastes generated and the severity of the potential ecological threat indicate a need for assessing ecological risks at these sites.

3.4.3 Nature of Oil and Gas Ecological Threats

The Oil and Gas Report to Congress presents 61 damage cases occurring in 13 states. Twenty-nine of the 61 cases (48 percent) contain documented evidence of ecological damage (not including any cases of damage solely to agricultural resources or drinking water). We selected 10 of these 29 cases that we feel are representative of the diverse existing and potential ecological impacts resulting from active oil and gas waste management operations for presentation in Exhibit II-7.

Observed Ecological Damages

Ecological damages at oil and gas waste sites may occur from short-term, acute, perhaps smaller-scale release events (e.g., from a spill) where damage to biota in contact with the wastes occurs, or as a result of long-term, chronic exposures (e.g., from low-concentration leaching from surface impoundments). The observed ecological damages from the cases presented in Exhibit II-7 include fish kills, benthic invertebrate population reductions, vegetation damage, elevated tissue residual levels of bioaccumulating organic chemicals, and severe alteration of invertebrate community structure. Different environments and varying regulatory influences also contribute to the diverse nature of ecological damages resulting from oil and gas waste activities. In Alaska, for example, State law permits production reserve pits to discharge liquid directly to roads and tundra. An estimated 100 million gallons is disposed in this manner, posing potentially widespread impacts on tundra vegetation and surface water aquatic fauna.

3.4.4 Characteristics of Oil and Gas Facilities Posing a Threat

Based on the damage case studies and discussion of oil and gas waste sites contained in the Report to Congress, we have summarized below the

EXHIBIT II - 7

DAMAGE CASE STUDY INFORMATION AVAILABLE DESCRIBING ECOLOGICAL IMPACTS AT OIL AND GAS WASTE SITES

Damage Case	Facility/Site Description	Characterization of Ecological Impacts
PA 09	Four county area with thousands of marginal stripper wells and abandoned drill pits in and around Allegheny Forest. 81 known improperly plugged oil wells in the Allegheny Reservoir.	Chronic low level releases of oils and oily, high-chloride produced water directly to soils and surface waters. "Lethal effect on trout streams and damage to timber and habitat for deer, bear, and grouse." Suppressed fish population in all streams of Allegheny Forest. Elevated levels of Ba, Fe, Mn, Methane, Cd, TDS, and aromatic HCs.
LA 20	Oil drilling barge situated in a bayou within 1,300 feet of active oyster harvesting and State oyster seeding area.	Drilling barge discharging drill cuttings and muds into bayou. High metal content of discharges may have long-term effect on commercial oyster fields due to accumulation of metals in sediments.
LA 45	Oil production facility located adjacent to a cypress swamp.	Discharge of high-chloride produced waters to nearby canal which empties into a cypress swamp. Estimated 4,088 acres of swamp "severely damaged;" 73 percent of the trees were dead and 18 percent were stressed. Salinity levels in canal = 32,000 ppm.
KS 03	Drilling activities near a farm and natural spring.	Discharge of 200-400 cubic feet of dissolved rock salt into unlined reserve pit. Conductivity of the springwater equaled 7,250 uhmos (2,000 uhmos is the accepted level at which soil damage occurs), impeding vegetative growth.
OK 06	Highly saline produced water injection well located on a private ranch.	Saltwater migration from injection zone to the ground surface. Surface soils and a nearby freshwater stream were contaminated, leading to aquatic and terrestrial vegetation kills.
TX 22	Drilling operation including a drilling muds reserve pit located near residential property.	Spreading of drilling muds (containing high levels of arsenic, barium, chromium, lead, sulfates, other metals, and chlorides) downhill from the site towards residential property. Drilling muds contaminated nearby surface soils and entered a draw area that flows into two private stock tanks -- killing over 700 fish.
CA 21	Oil production and drilling fields in California mountain valleys.	High chloride produced water discharged to ephemeral streams and diverted to central sumps for disposal through evaporation and infiltration to ground water. Potentially severe damage to ground water through infiltration of produced water. Birds and animals trapped in oily deposits in ephemeral streams.
AK 08	Drilling sites located near fish and waterfowl habitat on North Slope of Alaska.	Drilling fluids discharged to nearby fish and waterfowl habitat. Bioaccumulation of barium, titanium, iron, copper, and molybdenum documented in fish exposed to drilling fluids. Reduced fertility and growth observed in fish.
AK 12	Test drilling well site in tundra environment. Site includes a drilling fluid reserve pit.	Reserve pit berm wash out allowed drilling fluids to flow onto tundra. Fluids containing high levels of chromium, oil, and grease leached into soil downgradient from the pit. Vegetation kill area approximately one-half acre. Soil contamination of drill pad with salt and hydrocarbons likely to keep area barren for years. Site is in a caribou calving area.
AK 09	Drilling operations adjacent to an arctic wetland.	Leakage, spills, and discharge to nearby pond and arctic wetland environment led to destruction of all invertebrate and plant life in the contaminated pond. Contaminated pond sediments will impede repopulation of the waters and may leach constitutents to adjacent wetlands.

Source: Report to Congress: "Management of Wastes from the Exploration, Development, and Production of Crude Oil, Natural Gas, and Geothermal Energy," December, 1987.

ecological threat characteristics posed by oil and gas facilities in terms of the waste management practices, environmental settings, and primary wastes of concern at these facilities.

Waste Management Practices

The oil and gas waste management practices identified in the damage cases as threatening nearby ecosystems include storage or disposal in surface impoundments (13 cases), direct discharge to surface waters (12 cases), land application (5 cases), and underground injection (1 case).

Release of, and ecological exposure to, oil/gas contaminants occurred by leaching and/or runoff from surface impoundments in nine cases, direct discharge of wastes to the environment (surface water and tundra) in 13 cases, and via spills or land application of wastes in seven cases. Exhibit II-8 illustrates the distribution of release/exposure pathways associated with the oil and gas damage cases.

Environmental Setting

The oil and gas waste sites experiencing observed or potential ecological impacts are predominantly located near surface waters. Sixteen of the damage case sites are located near surface waters. Eight sites are located adjacent to wetland environments (including tundra). Six damage cases involve degradation of terrestrial vegetation. One of the 29 sites is adjacent to a sensitive habitat. Exhibit II-9 illustrates the distribution of environmental settings affected by the 29 oil and gas damage cases.

Wastes of Concern

The principal waste types contributing to the ecological damages at oil and gas waste sites are drilling muds, production brines and chlorinated wastewater, and general oil field effluents and fracturing fluids. Heavy metals and chlorides are the most commonly cited constituents in the damage cases and available documentation, though many other inorganics may be contained in the waste fluids (See Appendix F).

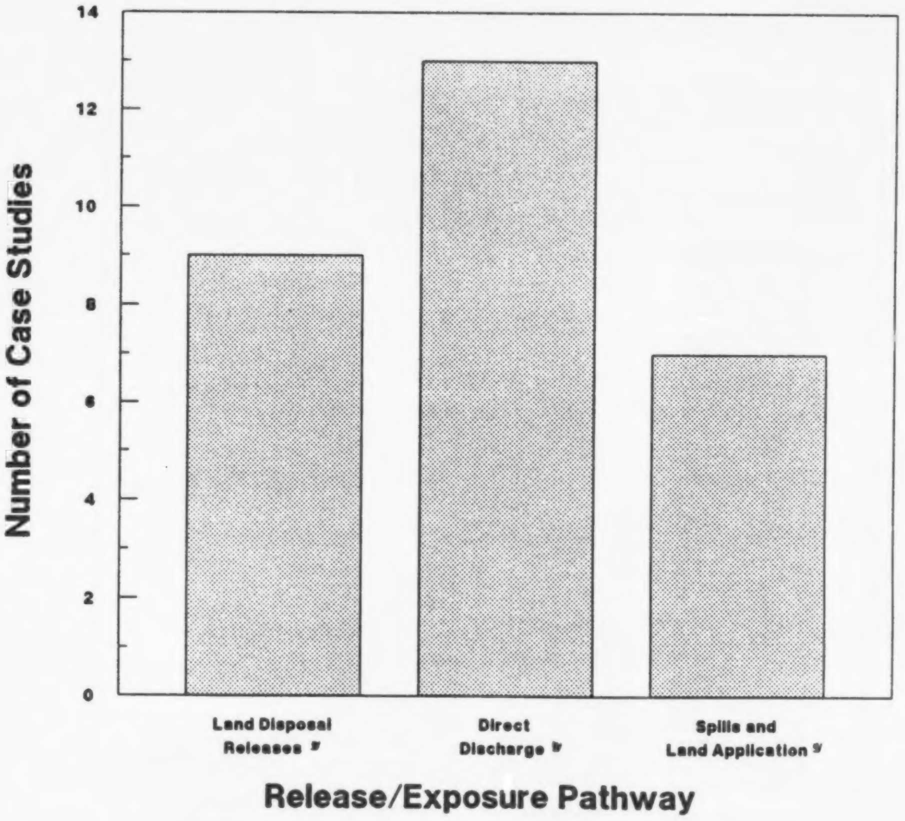
3.5 Coal-Fired Utility

3.5.1 Summary of Available Information

Only one source, the Coal Utilities Report to Congress, contained information relevant to our analysis of ecological risks resulting from coal utility waste management. This report includes general data and case study information pertaining to the nature and extent of observed and potential threats posed by these facilities. Our review of case studies for this section, however, is based only on the information presented in the Report to Congress, and therefore should not be interpreted to be comprehensive or entirely representative of impacts from all coal-fired utility waste facilities.

EXHIBIT II-8

OIL AND GAS CASE STUDY RELEASE/EXPOSURE PATHWAYS



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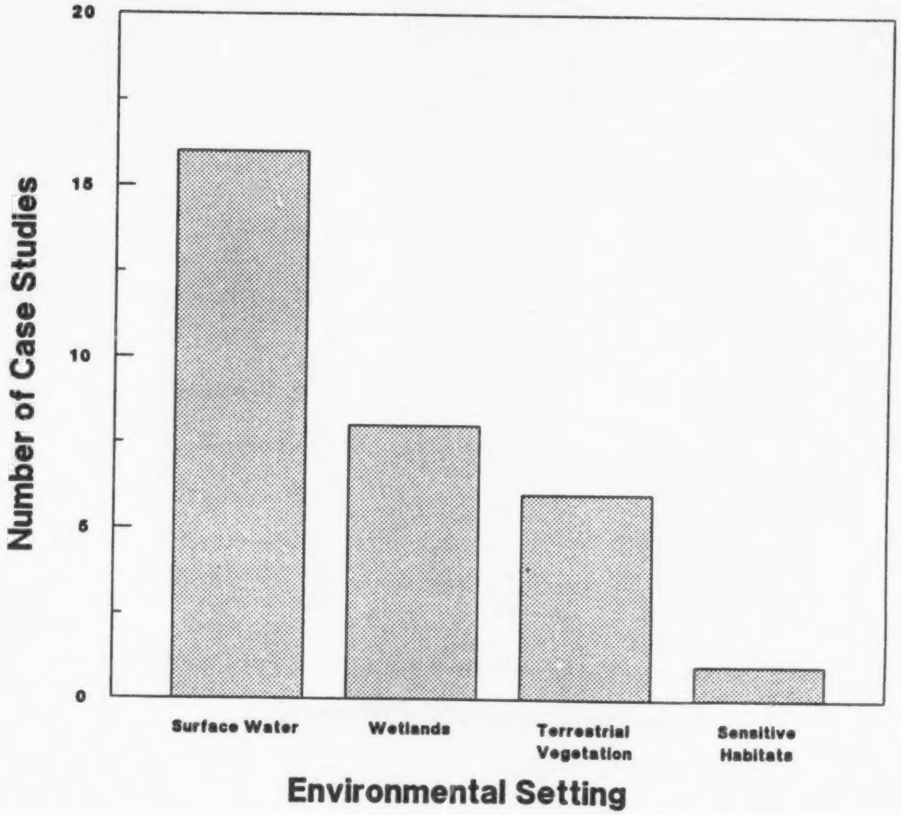
a/ Land disposal releases consist of leaching or overland flow of wastes or constituents from landfills, lagoons, pits, or ponds with subsequent migration to ecological receptors.

b/ Direct discharge of wastes or wastewaters to ecosystems (usually surface water).

c/ Spills and land application consist of migration of spilled or land applied wastes or constituents to ecological receptors.

EXHIBIT II-9

OIL AND GAS CASE STUDY ENVIRONMENTAL SETTINGS



3.5.2 Extent of Coal-Fired Utility Ecological Threats

In 1984, 514 coal utilities plants generated 90 percent of all fossil fuel combustion wastes, totalling nearly 69 million tons. The extent of ground-water contamination resulting from these sites is illustrated by the fact that out of 4,700 observations of well samples taken from 66 coal-fired utility sites in 13 states, contaminant concentrations in 7 percent (329) of the samples exceeded Primary Drinking Water Standards (PDWS), and 30 percent (1,410) exceeded Secondary Drinking Water Standards (SDWS). Based on data for a sample of 100 coal-fired utility waste sites obtained from the Nature Conservancy's Heritage Program, 12 facilities were situated within five kilometers of a Federally designated threatened or endangered species area; 29 facilities were within five kilometers of State designated critically endangered species areas; 32 facilities were within areas containing species or natural communities "of concern;" and 15 did not respond to the sampling study. As with the information gathered for oil/gas facilities, the data for coal-fired utility facilities was derived from summary information in the Report to Congress and should not be regarded as comprehensive and representative of all coal-fired utility facilities.

3.5.3 Nature of Coal-Fired Utilities Ecological Threats

The Coal-Fired Utilities Report to Congress presented 14 damage case studies in eight states. Five of these cases (36 percent) contained documented evidence of existing or potential ecological damage (not including any cases of damage solely to agricultural resources or drinking water). These five cases are briefly described in Exhibit II-10.

Observed Ecological Damages

Severe, large-scale contaminant-release incidents near aquatic ecosystems have resulted in extensive kills of fish, bottom-dwelling organisms, and aquatic and terrestrial plant life. The existence of other, perhaps less acute, aquatic and terrestrial effects (e.g., "visual indications of marsh contamination") and contaminated environmental media is also evident in the damage cases.

3.5.4 Characteristics of Coal-Fired Utility Facilities Posing a Threat

Based on the damage case studies and discussion of coal-fired utility waste sites contained in the Report to Congress, we have summarized below the coal utility facility characteristics associated with ecological threats. We discuss waste management practices, environmental settings, and primary wastes of concern at these facilities.

Waste Management Practices

Coal-fired utility waste management practices resulting in ecological damage typically involve the improper storage or mishandling of waste sludges and fly ash wastes. Among the case studies, discharge of wastes to surface water (2 cases), and waste storage in surface impoundments (2 cases) and a landfill (1 case) were responsible for the observed ecological threats.

EXHIBIT II - 10

DAMAGE CASE STUDY INFORMATION AVAILABLE DESCRIBING ECOLOGICAL IMPACTS AT COAL UTILITY WASTE SITES

Damage Case	Facility/Site Description	Characterization of Ecological Impacts
Envirosphere PA, 1975	Private waste handler illegally disposing fly ash to tidal wetland.	Visual indications of marsh contamination from fly ash leachate. Heavy metal-laden ash remaining in marsh threatens numerous wetland ecosystems. Impacts not yet determined.
Envirosphere CT, 1971	Municipal landfill located in a marsh accepts fly ash.	Surveys revealed numerous Secondary Drinking Water Standards (SDWS) contaminants present in the marsh that are derived from fly ash leachate. Potential risk to wetland species exists from heavy metals in ash.
Envirosphere VA, 1967	Fly ash settling lagoon situated near the Clinch River.	Collapse of a dike surrounding the fly ash settling lagoon, releasing 130 million gallons of caustic solution (pH 12) to the river. Fish kills extended 90 miles downstream. Reduction in bottom dwelling organisms extended to 77 miles below the site. All such organisms eliminated within 4 miles of site. Recovery period greater than two years.
D&M Hunts Brook Watershed	Fly ash disposed along three tributaries of Hunts Brook.	Sampling of surface water contamination downstream of dumping sites indicated levels of iron, sulfate, and dissolved solids 100 times those measured upstream. Levels of iron and TDS in the surface water increased from less than the SDWS upstream to over 100 and 44 times the SDWS, respectively, downstream from the site. No ecological effects were measured.
D&M Canesville Site	Disposal site for coal combustion waste. Sludge deposited next to fly ash pond.	Groundwater contamination -- potential for migration to nearby river. Contaminants include: cadmium, chromium, lead, arsenic. No ecological effects were measured.

Source: Report to Congress: "Wastes from the Combustion of Coal by Electric Utility Power Plants," February, 1988.

Environmental Setting

Though few data were available describing the locations of coal-fired utility waste sites, those sites identified in the damage cases as experiencing observed or potential ecological impacts were almost exclusively located near wetlands (2 cases) or other types of surface water bodies (2 cases). One of the five case studies is located in a floodplain.

Wastes of Concern

Fly ash wastes represent the most ubiquitous ecological threat posed by the coal-fired utilities. Heavy metals are the primary constituents of concern in this waste. The available documentation and case studies suggest that organic compounds are not of significant concern at coal-fired utility waste facilities (See Appendix F).

3.6 Smelting and Refining Waste

3.6.1 Summary of Available Information

The 1988 draft Smelting and Refining Report to Congress served as the sole source of information relevant to our analysis of ecological risks resulting from activities at smelting and refining facilities. This report includes data pertaining to the nature and extent of current and potential ecological threats posed by these facilities. The report describes practices at only copper, lead, zinc, and aluminum facilities.

3.6.2 Extent of Smelting and Refining Ecological Threats

Smelting and refining operations generate an estimated nine million metric tons of potentially hazardous wastes annually. According to the Report to Congress, 15 percent (1.35 MT) of these wastes are managed in unlined storage and/or disposal facilities. Contaminant concentrations in leachate waste streams from 17 smelting and refining waste storage sites were examined relative to Ambient Water Quality Criteria (AWQC) for eight hazardous constituents. All of these waste streams exceed the AWQC for at least one constituent. One should note, however, that many of the waste management practices documented in the Report to Congress may not currently be followed at smelting and refining facilities.

3.6.3 Nature of Smelting and Refining Ecological Threats

The 16 case studies contained in the Report to Congress, indicate releases may occur from smelting and refining facilities to all environmental media. Typical case studies describe devegetation and depletion of aquatic life as a result of surface water and soil contamination from leaching and wastewater discharge. Of sixteen case studies identified in the Report to Congress, ten sites that best represent the nature and extent of ecological threats at smelting and refining waste sites are presented in Exhibit II-11.

EXHIBIT II - 11

DAMAGE CASE STUDY INFORMATION AVAILABLE DESCRIBING ECOLOGICAL IMPACTS AT SMELTING AND REFINING SITES

Damage Case	Facility/Site Description	Characterization of Ecological Impacts
New Jersey Zinc Company Palmerton, PA	Primary zinc smelter and refinery that has been in operation since 1899. Ranked number 10 on Pennsylvania Superfund list as a result of past smelter stack emissions and contamination from a slag pile approximately two miles long, 1,000 feet wide and 400 feet high.	Leachate and runoff from the slag pile have contaminated Aquashicola Creek with cadmium, lead, zinc and copper concentrations approaching, and in some cases exceeding, 300 times the ambient water quality criteria for the protection of aquatic organisms. Almost complete devegetation of a mountainside near the smelter stack.
Kaiser Aluminum and Chemical Corporation Mead, WA	An active aluminum reduction facility that has stored spent potliners on-site since 1942.	Liquids from an on-site industrial wastewater settling pond were found to be seeping through soil and flushing contaminants from under the potliners. The ground-water plume extends as far as the Little Spokane River approximately two miles away.
Eastalco Aluminum Company Frederick, MD	Primary aluminum reduction facility that disposed of spent potliners in a landfill and also stored them on the ground.	Surface water sampling indicates that a tributary of the Tuscarora Creek that flows past the landfill area has had concentrations of cyanide ten times the chronic water quality criteria for the protection of aquatic organisms and 2.4 times the acute criterion.
ASARCO Smelter East Helena, MT	An active primary lead and by-product metals smelter and an inactive zinc smelter. Contaminant sources include stack emissions, a 30-acre slag pile, a 21-acre ore storage area, and holding pond for process fluids. The site is currently on the Superfund NPL.	Sampling of surface soil, ground water, and air shows contamination with metals. Livestock and crops contain higher than normal levels of metal, and there is a direct correlation of these levels with the soil concentration.
ORMET Corporation Hannibal, OH	This facility is a primary aluminum reduction plant. Cryolite recovery slurry is stored in a lagoon, and residual spent potliner debris persists on-site from previous landfillings.	On-site sampling data from 1983 show contamination with fluoride at 30 times the drinking water standard and cyanide of 50 times the water quality criteria.
Reynolds Metal Company Longview, WA	An aluminum reduction plant that has been in operation from 1941 to present. The main contamination sources are the potliner storage piles and the cryolite sludge lagoons.	In 1983, fluoride and cyanide were measured in on-site monitoring wells at concentrations 700 times drinking water standards and 500 times water quality criteria, respectively. Ground-water flows towards the Columbia River.
Eagle Mine Belden, CO	A mine and processing facility that operated from 1880 to 1983 and is currently on the Superfund NPL. Eagle River flows next to zinc roaster piles.	Based on 1985 sampling data, concentrations of zinc, copper, cadmium, and lead in the river at a point adjacent to the roaster piles are 24, 5, 4, and 7 times, respectively, the chronic ambient water quality criteria for the protection of aquatic organisms, and 4, 3, 1 and 3 times the acute criteria. The river is used along its entire length for fishing and other recreation.
Silver Bow Creek, MT	Superfund site influenced by historic regional mining, milling, and processing operations.	Sampling indicates both ground water and surface water are contaminated by many metals at levels greater than drinking water standards.
Bunker Hill Site Shoshone County, ID	An inactive mine, mill, and smelter of lead, zinc, and other metals. Metal processing wastes include a 160-acre slurry pond, slag piles, and a gypsum pond.	Surface waters are contaminated with metals at levels greater than drinking water standards and ambient water quality criteria for the protection of aquatic organisms. Fish are not able to live in the section of the Coeur D'Alene River adjacent to the site.
Anaconda Smelter Mill Creek, MT	Copper smelter in operation between 1884 and 1980, currently listed on Superfund NPL.	Zinc and copper contamination of surface water exist at levels up to five times the drinking water standards and 400 times both the chronic and acute water quality criteria for the protection of aquatic organisms.

Source: Report to Congress: "Solid Waste from Selected Metallic Ore Processing Operations," Draft July 15, 1988.

Observed Ecological Damages

Ecological damages may occur as a result of long-term, chronic exposure from the continuous release of low concentration leachate. The potential for short-term, acute exposures also exist. Contaminant concentrations up to 400 times both the chronic and acute water quality criteria for the protection of aquatic organisms have been observed in surface waters adjacent to smelting and refining sites.

3.6.4 Characteristics of Smelting and Refining Facilities Posing a Threat

Based on the damage case studies and discussion of smelting and refining waste sites contained in the Report to Congress, we have summarized below the smelting and refining facility characteristics associated with ecological threats. We discuss facility characteristics in terms of the waste management practices, environmental settings, and primary wastes of concern at these facilities.

Waste Management Practices

Smelting and refining waste management practices include the storage or disposal of wastes in landfills (3 cases), settling or sludge ponds/lagoons (4 cases), and waste piles (5 cases). Direct discharge of wastes to surface waters or soils is the primary management practice in two cases.

Exhibit II-12 depicts the observed release/exposure pathways resulting from smelting and refining management practices. Seven cases involve a continuous, intermittent, or seasonal seepage to ground water with subsequent migration to ecological receptors. In 4 of the 11 cases, overland releases from ponds, piles, or dumps provided the release/exposure pathway. Two cases implicated deliberate releases in the observed ecological damages.

Environmental Setting

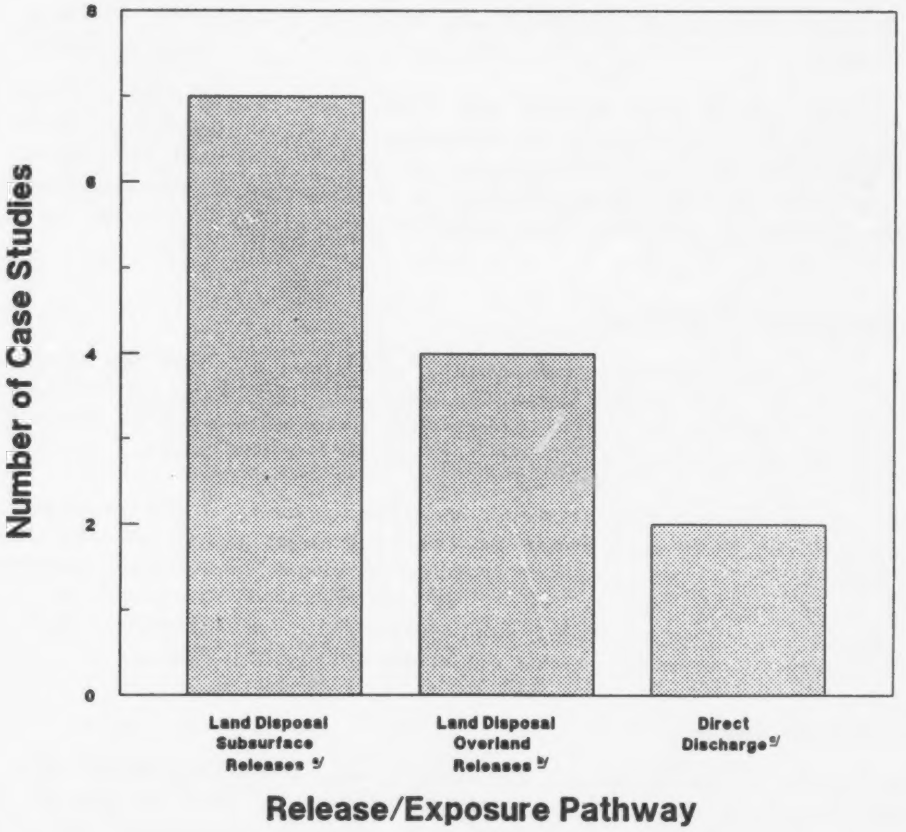
The proximity of smelting and refining sites to surface water may influence the potential threat to aquatic environments. Over 70 percent of the sites examined in the Report to Congress were found to be within 2,000 feet of surface water.

Wastes of Concern

The predominant waste types contributing to the ecological damage at smelting and refining waste sites are spent potliners, cryolite slurries, cryolite sludges, slags, and process fluids. Heavy metals are the primary constituents of concern found at these waste sites. The frequency in which these contaminants occur is dependent upon the industry sector (e.g., copper or zinc smelting). The available documentation and case studies suggest that organic compounds are not of significant concern at smelting and refining waste sites (See Appendix F).

EXHIBIT II-12

SMELTING AND REFINING CASE STUDY RELEASE/EXPOSURE PATHWAYS



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a/ Land disposal subsurface releases consist of leaching of wastes or constituents from landfills, lagoons, pits, or ponds with subsequent migration to ecological receptors.

b/ Land disposal overland releases consist of runoff from landfills, lagoons, pits, or ponds to ecological receptors.

c/ Direct discharge of wastes or wastewaters to ecosystems (usually surface water).

CHAPTER 4

SUMMARY AND CONCLUSIONS

The preceding sections have discussed the available information describing the documented and observed characteristics of ecological threats at RCRA facilities. The six RCRA facility-types or program areas investigated were Subtitle C, Subtitle D, Mining Waste, Coal Utilities, Oil and Gas, and Smelting and Refining. The extent of the ecological threats at these facilities has been summarized in a variety of broad regulatory and policy analyses conducted by OSW and the EPA Regional Offices and are further addressed in this study through OPA's interviews of RCRA professionals in the EPA Regions and States. The nature of these threats also has been summarized in the various OSW studies and are further described in this paper through the development and analysis of damage case studies for each RCRA program area.

4.1 Summary of Extent and Nature of Ecological Threats at RCRA Facilities

Extent of the Ecological Threat

The extent of ecological threats at RCRA facilities has been generally described in Regulatory Impact Analyses, Reports to Congress, Background Documents, and special reports prepared by OSW and the EPA Regions. Although few of these sources investigate the extent of ecological impacts in great detail, they do provide some indication of the problem. For example, a high percentage of the RCRA facilities were found to have experienced a release to the environment; an estimated 71 percent of the Subtitle D facilities and 62 percent of the Subtitle C facilities have incurred resource damages as a result of such releases. OSW estimates that 17 percent of all Subtitle C TSDFs will require surface water cleanup, 34 percent will require soil cleanup, 30 percent will require ground-water cleanup, and seven percent of the facilities will require air cleanup. Roughly 11 million barrels of oil and gas drilling wastes are released annually from over 9,000 spills. Furthermore, an estimated 26 percent of the active mining and 32 percent of the coal utility facilities are within five kilometers of sensitive environmental areas. Seventy-eight percent of the phosphate mines sampled were within five kilometers of wetlands, and 60 percent of the mining case studies reported effects on non-human biota. Hence, waste management activities conducted under all of these RCRA program areas pose a substantial potential threat to the environment.

OPA's interviews of 51 EPA Regional and State RCRA professionals provided preliminary results about extent of ecological threats at RCRA Subtitle C facilities. Primary findings from these interviews are summarized below.

- Many RCRA facilities may pose ecological threats, but due to the relative youth of the RCRA program and the relative lack of attention given to ecological risks, there is little available documentation to support any assessments or conclusions about the nature and extent of ecological threats presented by RCRA facilities.

- The EPA Regional and State professionals identified 52 RCRA Subtitle C facilities with known, suspected, or potential ecological damages. We were able to obtain documentation of the site conditions and history for 16 of these 52 facilities.

- There has been little emphasis placed on collecting ecological information either at the program analysis or site-specific assessment level. Therefore, when ecological information has been collected, it may not be truly representative of the nature and extent of the problem.

- Interviewees from six Regions stated that ecological threats at RCRA facilities are given inadequate consideration. This inadequacy was attributed to a lack of appropriate assessment methods, a lack of guidance, the impression that ecological concerns are "too big to deal with," program emphasis on human health, and an inability to address terrestrial threats. Only one interviewee suggested that current considerations of ecological threats in RCRA were adequate.

Nature of the Ecological Threat

The precise nature of the ecological threats at RCRA facilities is not well understood, but there are a number of examples of observed and predicted ecological damages at RCRA facilities. Based on these examples, we can summarize the nature of ecological threats posed by RCRA facilities as follows.

- The severity of ecological threats depends on

    - environmental setting (e.g., wetlands),
    - facility size (i.e., quantity of wastes released),
    - toxicity characteristics of the constituents released, and
    - the nature of the release event itself (e.g., flooding, leaching to soil).

- Observed ecological damages from RCRA facility releases have been long- and short-term in nature, and include fish kills, diseased or desecrated benthic habitats, chronic or behavioral effects on aquatic and terrestrial plant and animal species, oyster mortality, reduced floral and faunal species diversity, and reduced productivity in wetland habitats.

- Evidence of potential ecological effects include increased contaminant body burdens in aquatic species, concentrations in water and soil that exceed water quality criteria or other levels of concern, sparse vegetation, and contaminated soils.

- It is not clear whether most ecological damage actually does occur in aquatic habitats, or it is simply easier, and therefore more common, to characterize impacts in this medium.

The wide range of hazardous substances managed at RCRA facilities, the numerous release and exposure pathways, and the diverse nature of the observed ecological impacts indicates that releases from these facilities have the potential to affect all environmental media and known ecosystems.

4.2 Summary of Ecological Threat Characteristics Among RCRA Program Areas

Our comparison of ecological threat characteristics among the identified RCRA program areas is hindered by the representativeness of the data describing these characteristics. In collecting the data for this analysis, disproportionate attention was paid to specific programs, geographic locations, and facility types. Nonetheless, we feel that certain trends and distinctions are evident among the characteristics associated with ecological threats in the various RCRA program areas. These trends and distinctions are discussed below.

Management Practice

The predominant waste management practice posing ecological threats at the RCRA areas is the storage or disposal of wastes in unlined surface impoundments. This practice has led to catastrophic releases through containment structure failure as well as long-term leaching of hazardous constituents to soils, ground water, and surface water bodies. At oil and gas facilities, the reinjection or surface discharge of high-chloride produced waters has posed a major threat. Storage in waste piles at mining and Subtitle C (and most likely other facility types as well) has caused damages through surface runoff and leaching to the soils and ground water. In sum, a variety of land disposal practices have resulted in ecological damages.

Environmental Setting

The environmental setting of a waste management facility is a critical determinant of the ecological risk presented by the facility. Environmental setting influences ecological risk by determining the potential for receptors to be exposed to releases. For a setting to pose a threat, it must contain pathways for releases to enter biologically active environments and also contain receptors that can potentially be exposed to such releases. Examples of settings with high ecological risk potential based on the presence of exposure pathways include wetlands, floodplains, and other locations near or adjacent to surface waters. Surface water contamination occurs through numerous pathways, the most predominant being leaching of contaminants to ground water that is hydrologically connected to surface water, and direct discharge or surface runoff to surface water bodies. Examples of settings with high ecological risk potential based on the presence of valued potential receptors include wetlands, endangered and threatened species habitat, and wildlife refuges.

Waste Types

A wide variety of hazardous constituents have been linked to ecological damages at RCRA facilities. Solvents, other VOCs, and metals have caused damage at Subtitle C facilities. Metals, pesticides, and biological contaminants pose ecological threats at Subtitle D facilities. The waste types managed at large-volume, special waste facilities tend to be dominated by heavy metal constituents. In particular, heavy metals make up a high percentage of coal utility fly ash, mining tailings, oil field effluents, and smelting sludges. High-chloride content process and waste waters are also a significant threat at most RCRA facilities.

Summary

Exhibit II-13 presents a summary table highlighting the ecological threat characteristics of each of the RCRA program areas discussed in Chapter 3. Based on the information available for each RCRA area, the table describes the observed damages, management practices, environmental settings, and wastes of concern that are most representative of the facilities which pose ecological threats. It is again noteworthy that the Subtitle C facility data was obtained through first-hand analysis of available damage cases, while for the remaining five RCRA program areas, the information contained in this report is based on OPA's review of damage cases described in program analysis and regulatory development documentation.

Although this analysis of facility characteristics reveals some patterns concerning practices, wastes, and settings that pose the most severe ecological threats, it is questionable whether these results can be extrapolated to the RCRA facility population as a whole. Such extrapolations are tenuous mainly due to the limited nature of the available data characterizing the RCRA facilities. Over time, as more representative data is collected, certain facility characteristics or waste management practices may emerge as particularly severe ecological threats. In the interim, we can simply summarize available information and observe trends in ecological impacts.

One main conclusion can be drawn from this analysis, however. RCRA facilities are experiencing releases of a wide variety of hazardous and non-hazardous constituents. The severity of the ecological impact caused by these releases is largely dependent on a facility's environmental setting. Hence, releases in wetlands, floodplains, surface waters, or in ecologically vital or sensitive habitats should be considered a potential source of ecological damage.

EXHIBIT II - 13

OBSERVED ECOLOGICAL THREAT CHARACTERISTICS OF RCRA PROGRAM AREAS

Program Area	Observed Ecological Damages	Waste Management Practices	Environmental Settings	Waste Types
Subtitle C	▪ Mortality - fish and vegetation kills ▪ Decreased species richness and diversity ▪ Increased body burden of toxicants ▪ Decreased productivity ▪ Altered life cycles ▪ Habitat alteration	▪ Landfills ▪ Surface impoundments (unlined) ▪ Container storage ▪ Wastewater discharge ▪ Waste piles	▪ Near surface waters ▪ Wetlands ▪ Special habitats (i.e., endangered and protected species habitat, and wildlife refuge)	▪ Metals - Cr, As, Pb, Hg ▪ Aromatic hydrocarbons and substituted aromatic compounds ▪ Solvents ▪ Other VOCs ▪ Creosote ▪ PCBs ▪ Acids ▪ Alkali ▪ Pesticides
Subtitle D	▪ Impaired overall health and fertility of freshwater and estuarine fish and macro-invertebrates ▪ Potential for contamination to all environmental media and thus widespread effects to terrestrial and aquatic species	▪ Uncontained disposal (e.g., dumping to surface waters) of combustion fly ash ▪ Storage in unlined landfills of all municipal wastes	▪ Limited available data ▪ 13 percent of facilities in 100-year floodplain ▪ 6 percent in wetland areas	▪ Particulates ▪ BOD ▪ Microbes ▪ Heavy Metals ▪ Pesticides ▪ VOCs ▪ PCDFs ▪ PCDDs
Mining	▪ Fish kills ▪ Impairment and reduction in bird, benthic and other aquatic organisms population ▪ Bioaccumulation in terrestrial organisms	▪ Tailings ponds ▪ Waste storage piles ▪ Waste hauling ▪ Surface impoundment ▪ Cyanide wash stored in drums	▪ Near surface waters	▪ Tailings, overburden, leachate solution, and mine water containing: cyanide, arsenic, copper, zinc, cadmium, lead, cobalt, silver, chromium, iron, TSS, pH
Oil and Gas	▪ Chronic and acute damages ▪ Fish kills, benthic invertebrate population reductions ▪ Reduced fertility and growth in aquatic species ▪ Vegetation damage ▪ Bioaccumulation ▪ Alteration of community structure	▪ Drilling operations ▪ Storage and disposal of drilling wastes in faulty surface impoundments ▪ Injection or discharge of process waters to ground surface	▪ Near surface waters ▪ Desert or tundra environment	▪ Drilling muds, production brines, chlorinated wastewater, and oil field effluents and fracturing fluids containing: chlorides, benzene, lead, phenanthrene, barium, arsenic, fluoride, antimony
Coal Utility	▪ Fish kills ▪ Eradication of bottom-dwelling organisms and other aquatic and terrestrial plant and animal life ▪ Chronic effects also likely	▪ Improper storage or mishandling of waste sludges and fly ash wastes ▪ Illegal or improper dumping of wastes ▪ Failure of surface impoundments	▪ Limited available data ▪ Predominantly near surface water bodies	▪ Fly ash wastes containing heavy metals (aluminum, arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium and silicon)
Smelting and Refining	▪ Chronic and acute damages to aquatic organisms ▪ Surface water contaminant concentrations >400 times AWQC	▪ On-site wastewater settling ponds ▪ Cryolite sludge lagoons ▪ Storage and disposal of spent potliners	▪ Over 70 percent within 2,000 feet of surface water	▪ Spent potliners, cryolite slurries, cryolite sludges, slags, and process fluids containing: zinc, copper, cyanide, lead, cadmium and fluoride

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Wyman-Gordon: North Grafton, MA.

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APPENDIX A

MASTER LIST OF SUPERFUND SITES IDENTIFIED AS POTENTIALLY HAVING ECOLOGICAL RISKS/IMPACTS

MASTER LIST OF SUPERFUND SITES IDENTIFIED AS POTENTIALLY HAVING ECOLOGICAL RISKS/IMPACTS

EPA Region 1

Beacon Heights Inc., Beacon Falls, CT
Brunswick Naval Air Station, Brunswick, ME
Cannon Engineering/Plymouth Harbor, Plymouth, MA
Charles George Land Reclamation, Tyngsborough, MA
Coakley Landfill, North Hampton, NH
*Davis Liquids, Smithfield, RI
Dover Municipal Landfill, Milford, NH
Groveland Wells 1 & 2, Groveland, MA
Grugnale Waste Disposal Site, Milford, NH
Haverhill Municipal Landfill, Haverhill, MA
Industri-Plex 128, Woburn, MA
*Iron Horse Park, Billerica, ME
Kellogg-Deering Well Field, Norwalk, CT
McKin Co., Gray, ME
Mottelo Pig Farm, Raymond, NH
*New Bedford Harbor, New Bedford, MA
Norwood PCB Site, Norwood, MA

Nyanza Chemical, Ashland, MA
*O'Connor Site, Augusta, ME
*Old Springfield Landfill, Springfield, VT
O'Sullivan's Island, Derby, CT
Peterson/Puritan Site, Lincoln/Cumberland, RI
Picillo Farm, Coventry, Coventry, RI
*Re-Solve, Inc., Dartmouth, MA
Savage Municipal Water Supply, Milford, NH
Somersworth Landfill, Somersworth, NH
Stamina Mills, Inc., North Smithfield, RI
*Sullivan's Ledge, New Bedford, MA
Sylvester, Nashua, NH
Tinkham Garage, Londonderry, NH
Wells G&H, Woburn, MA
Western Sand and Gravel, Burrillville, RI
Yaworski Waste Lagoon, Counterbury, CT

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* Denotes sites analyzed in detail for this study.

MASTER LIST OF SUPERFUND SITES IDENTIFIED AS POTENTIALLY HAVING ECOLOGICAL RISKS/IMPACTS (continued)

EPA Region 2

Albert Steel Drum, Newark, NJ
Applied Environmental Services, Glenwood Landing, NY
Bog Creek Farm, Howell Township, NJ
Brick Township Landfill, Brick Township, NJ
Burnt Fly Bog, Marlboro Township, NJ
*Chemical Control, Elizabeth, NJ
Chipman Chemical, Middlesex, NJ
Chemical Leaman, Bridgeport, NJ
Ciba-Geigy, Toms River, NJ
Clear Ambient Service, Catano, PR
*Clothier, Granby, NY
Cosden Chemical Coatings, Corp., Beverly, NJ
Curcio Scrap Metal, Inc., Saddle Brook Township, NJ
DeRewal Chemical Co., Kingwood Township, NJ
Denzer and Schafer X-Ray, Royville, NJ
Diamond Alkali, Newark, NJ
Droyers Point, Jersey City, NJ
Frontera Creek, Rio Abajo, PR
Fried Industries, East Brunswick Township, NJ
Hercules, Inc., Gibbstown, NJ
Horstmann's Dump, West Hanover, NJ
Horseshoe Road Dump, Sayreville, NJ
*Hudson River PCBs, Glen Falls, NY
Ideal Cooperage, Jersey City, NJ
Jackson Township Landfill, Jackson Township, NJ
Jones Sanitation, Hyde Park, NY
Kin-Buc Landfill, Edison Township, NJ
Koppers Company, Metuchen, NJ
Krycowety Farm, Hillsborough, NJ

Liberty Industrial Finishing, Farmingdale, NY
*Lipari Landfill, Pitman, NJ
*Marathon Battery, Cold Springs, NY
Mobil Chemical Company, Carteret, NJ
Myers Property, Franklin Township, NJ
N.L. Industries, Pedricktown, NJ
Naval Air Engineering Center, Lakehurst, NJ
North Sea Municipal Landfill, Southhampton, NY
Perth Amboy's PCBs, Perth Amboy, NJ
PJP Landfill, Jersey City, NJ
Pollution Abatement Services, Oswego, NY
Port Washington Landfill, Port Washington, NY
Price Landfill, Pleasantville, NJ
Ringwood Mines/Landfill, Ringwood Borough, NH
Roebling Steel Company, Florence, NJ
Roosevelt Drive-In, Jersey City, NJ
Rowe Industries Ground Water Cont., Noyack/Sag Harbor, NY
Sayerville Landfill, Sayerville, NJ
Sayerville Pesticide, Sayerville Borough, NJ
Scientific Chemical Processing, Carlstadt, NJ
Solvent Savers, Lincklaen, NY
Syncon Resins, South Kearney, NJ
T. Fiore Demolition, Inc., Newark, NJ
Universal Oil Products Inc., East Rutherford, NJ
Ventron/Velsicol, Wood Ridge Borough, NJ
Vineland, Chemical, Vineland, NJ
White Chemical Company, Bayonne, NJ
Wide Beach, Brant, NY
Williams Property, Swainton, NJ
York Oil, Moire, NY

MASTER LIST OF SUPERFUND SITES IDENTIFIED AS POTENTIALLY HAVING ECOLOGICAL RISKS/IMPACTS (continued)

EPA Region 3

Aberdeen Proving Ground, Edgeworth Area, Edgeworth, MD
Aberdeen Proving Ground, Michaelsville Landfill, Aberdeen, MD
*Army Creek Landfill, New Castle Co., DE
Atlantic Wood Ind., Portsmouth, VA
Bridesburg Dump, Pennsylvania
Butler Mine Tunnel, Pittsburgh, PA
C&R Battery Co. Inc., Chesterfield County, VA
*Chisman Creek, York County, VA
Cokers Sanitation Services Landfills, Kent County, DE
Croydon TCE, Croydon, PA
Delaware City PVC Plant, Delaware City, DE
*Delaware Sand and Gravel Landfill, New Castle Co., DE
Delta Quarries and Disposal/Statler Landfill, Blair Co. PA
*Douglassville Disposal, Douglassville, PA
Dover Gas and Light Co., Dover, DE
E.I. DuPont (Newport Plant Lf), Newport, DE
Enterprise Avenue, Pennsylvania
Halby Chemical Company, New Castle, DE
Hellertown Manufacturing Co., Hellertown, PA
Joy Reclamation Co., Maryland
*L.A. Clarke, Fredericksburg, VA
Maryland Sand, Gravel, and Stone, Elkton, MD
Metal Bank of America, Philadelphia, PA
National Cash Register Corp., Millsboro, DE
New Castle Spill Site, New Castle Co., DE
*New Castle Steel, New Castle Co., DE
Old Brine Sludge, Delaware
*Palmerton Zinc, Palmerton, PA
Paoli Rail Yards, Paoli, PA
Pigeon Point Landfill, New Castle, DE
Revere Chemical Company, Nockamixon, PA
Rohm and Haas Landfill, Bristol Township, PA
Saltville Waste Disposal, Saltville, VA
Saunders Supply Co., Chesterfield County, VA
Southern Maryland Wood Treating, Hollywood, MD
Standard Chloring of Delaware, Inc., Delaware City, DE
Tinicum National Environmental Center, Darby Township, PA
*Tybouts Corner Landfill, New Castle Co., DE
*Tyson's Dump, Upper Merion TWP, PA
Wade (ABM) Site, Chester, PA
*West VA Ordnance, Point Pleasant, WV
*Wildcat Landfill, Dover, DE
*Winchester Tire Fire Site, Frederick Co., VA
Woodlawn County Landfill, Woodlawn, MD

EPA Region 4

*American Creosote Works, Pensacola, FL
Bypass 601, Concord, NC
*58th St. Landfill, Tampa, FL
*Geiger (C&M Oil), Charleston County, SC
*Harris Corporation/General Development Utilities, Palm Bay, FL
*Mowbray Engineering, Greeneville, AL
*Munisport Landfill, North Miami, FL
*Newport Dump, Newport, KY
Newsom Brothers/Old Reichhold, Columbia, MS
*Parramore Surplus, Mount Pleasant, FL
Peak Oil/Bay Drum Co., Tampa, FL
Pickettville Landfill, Jacksonville, FL
*Sapp Battery Salvage, Cottondale, FL
Sherwood Medical, DeLand, FL
*62nd Street Dump, Tampa, FL
*Stauffer Chemical Co. (LeMoyne Plant), Axis, AL
Triana-Tennessee River, Limestone/Morgan, AL
Wamchem, Inc., Burton, SC

MASTER LIST OF SUPERFUND SITES IDENTIFIED AS POTENTIALLY HAVING ECOLOGICAL RISKS/IMPACTS (continued)

EPA Region 5

Belvidere Landfill, Belvidere, IL
Bennett Stone Quarry, Bloomington, IN
Douglass Road Uniroyal, Mishawaka, IN
*Eau Claire Municipal Well Field, Eau Claire, WI
Envirochem, Zionsville, IN
Fields Brook, Ashtabula, OH
Firestone Ind. Products, Nobelsville, IN
Fishercalo, LaPort, IN
*Fort Wayne Reduction, Fort Wayne, IN
*Fultz Landfill, Guerney County, OH
G&H Landfill, Utica, MI
Lake Sandy Joe, Gary, IN
Lemaon Lane Landfill, Bloomington, IN
*Liquid Disposal, Inc., Utica, MI
*Marion/Bragg Landfill, Marion, IN
MIDCO 1 and 2, Gary, IN
Neal's Dump, Spencer, IN
Neal's Landfill, Bloomington, IN
Ninth Ave. Dump, Gary, IN
Oconomowoc Plating, Ashippin, WI
*Outboard Marine, Waukegan, IL
Prestolite Battery, Vincinnes, IN
Reilly Tar Site, St. Louis Park, MN
Rose Township Dump, Rose Township, MI
Sangamo/Crab Orchard NWR (USDOI), Carterville, IL
*Schmalz Dump, Harrison, WI
*Seymour Recycling Corp., Seymour, IN
Sheboygan Harbor, Sheboygan, WI
South Branch of Shiawassee River, Shiawassee Co., MI
Twin Cities Army Arsenal, St. Paul, MN
*Velsicol Chemical, Marshall, IL
Waste, Inc., Landfill, Michigan City, IN
Wayne Waste Oil, Columbia City, IN

EPA Region 6

American Creosote, Winnfield, LA
Anderson Clayton, Inc., Thorndale, TX
Baily Waste Disposal, Bridge City, TX
Bayou Bonfouca, Slidell, LA
Bayou Sorrel, Bayou Sorrel, LA
French Limited, Crosby, TX
Gurley Pit, Edmondson, AR
*Mid-South Wood Products, Mena, AR
Motco Corp., La Marque, TX
Petro Processors, Scotlandville, LA
Sand Springs Petrotrochemical, Sand Springs, OK
Sikes Disposal Pits, Crosby, TX
*United Nuclear Uranium Mill, Church Rock, NM
Vertac, Jacksonville, AR
*Wichita Mtn. Wildlife Refuge, Comanche Co., OK

MASTER LIST OF SUPERFUND SITES IDENTIFIED AS POTENTIALLY HAVING ECOLOGICAL RISKS/IMPACTS (continued)

EPA Region 7

Conservation Chemical, Kansas City, MO
Horse Arena Sites, Missouri
Minker/Stout/Romaine Creek (Romaine Creek Operable Unit), Jefferson Cty, MO
Minker/Stout/Romaine Creek (Stout Site), Jefferson County, MO
Rosati, Rosati, MO

EPA Region 8

Anaconda Co. Smelter, Anaconda, MT
California Gulch, Leadville, CO
Central City/Clear Creek, Idaho Springs, CO
Eagle Mine, Minturn/Radcliff, CO
*Martin Marietta Astronautic, Waterton Facility, CO
Rocky Mtn. Arsenal, Denver, CO
*Sand Creek Industrial, Commerce City, CO
Silver Bow Creek, Silver Bow/Deer Lodge, MT
White Wood Creek, White Wood, SD

EPA Region 9

Apache Powder Co., Benson, AZ
Coast Wood Preserving, Ukiah, CA
Del Norte County Pesticide Storage Area, Crescent City, CA
*Iron Mountain Mine, Redding, CA
Liquid Gold Corporation, Richmind, CA
Litchfield Airport, Goodyear/Avondale, AZ
MGM Brakes, Cloverdale, CA
Moffett Field Naval Air Station, Sunnyvale, CA
Montrose Chemical Corp., Torrance, CA
Pearl City Landfill, Pearl Harbor, HI
Phelps Dodge, Arizona
Rhone-Poulenc, Inc./Zoecon Corp., East Palo Alto, CA
Selma Pressure Treating, San Joaquin Valley, CA
*Southern Pacific Coalinga, Coalinga, CA
Taputima Farm, Tutuila Island, AS

EPA Region 10

Allied Plating, Inc., Portland, OR
Bunker Hill, Kellogg, ID
Commencement Bay, Tacoma, WA
Gould, Inc., Portland, OR
Harbor Island, Seattle, WA
Martin Marietta Reduction, The Dallas, OR
NAS Whidbey Island (Ault Field), Whidbey Island, WA
NAS Whidbey Island Seaplane Base, Whidbey Island, WA
Naval Undersea Warfare Engineering Station, Keyport, WA
*Queen City Farms, Maple Valley, WA
Quendall Terminal, Renton, WA
Stauffer Chemical, Co., Portland, OR
Tacoma Landfill, Tacoma, WA
Teledyne Wah Chang, Albany, OR
Western Processing, Kent, WA
Wycoff/Eagle Harbor, Bainbridge Island, WA

APPENDIX B

ECOLOGICAL THREAT DATA FOR INDIVIDUAL SUPERFUND SITES

The pages that follow provide a summary of ecological threat information at 46 of the 52 Superfund sites studied in this project. Relevant information for six sites has been withheld because it was extracted from draft reports that are confidential or not publicly available. The information that is presented is based on the data contained in the documents reviewed and is limited by the completeness and accuracy of these original sources. The major categories of information provided for each site are explained below.

- Site Name, City, State, and EPA Region. This information is self-explanatory. The sites are ordered alphabetically within groups for each region.

- Type of Site. This identifies the general type of process or waste management practices used at the site. Other descriptive information is given as appropriate.

- Principal Contaminants. This section lists the main inorganic and organic contaminants observed in environmental media at the sites. The listed contaminants are not necessarily the ones contributing most to ecological impacts. In fact, at many sites, the contaminants that were tested for were of concern primarily from a human health standpoint.

- Media/Biota Observed to be Contaminated. These are observed environmental media and general categories of biota observed to be contaminated as documented in the reports reviewed. Media or biota that are potentially contaminated are not listed in this section.

- Main Ecological Risks/Impacts. This section summarizes available information on the nature and extent of ecological threats, separate from that provided earlier. Specifically, it provides information (when available) on biological effects, the areal extent of media-specific contamination, the magnitude or severity of exposure to biota, and sensitive environments that may be affected. Information on both observed impacts and predicted (or potential) impacts is provided, with "potential" impacts explicitly noted as such. Furthermore, the information provided in this section primarily is limited to observed or predicted effects noted by the authors of the reports that were reviewed. In a few cases, potential effects not accounted for by the authors are listed, and these effects are highlighted with an asterisk.

- Documents Reviewed. The documents on which the above information is based are listed in this section.

EPA REGION 1 SITES

O'CONNOR SITE
AUGUSTA, ME
REGION 1

Type of Site: inactive transformer recycling and salvage yard

Major Release Pathways:

- direct release from transformers scattered around the site
- drainage of lagoon water into Riggs Brook
- spills of transformer oils into surface water

Principal Contaminants:

- inorganics: Al, Sb, As, Pb
- organics: PCBs

Media/Biota Observed to be Contaminated:

- onsite vegetation
- fish (Riggs Brook)
- amphibians (Riggs Brook)
- surface soil
- surface water sediments
- ground water
- lagoon waters (upper and lower lagoons)

Main Ecological Risks/Impacts:

- bioaccumulation of PCBs in fish range from 3X - 21X greater than background levels
- areas of site have discolored soil and are barren of vegetation
- bioaccumulation of PCBs in tadpoles
- potential reduced growth and altered community structure in microorganisms and microinvertebrates in lagoons, marsh, and Riggs Creek due to elevated PCB concentrations in interstitial water of sediments
- concentrations of aluminum (marsh and lower lagoon) and lead (marsh, upper lagoon, lower lagoon, and Riggs Brook) exceed AWQC and are likely to be toxic to aquatic organisms
- potential contamination of and toxicity to terrestrial wildlife from

contaminated microinvertebrates in marsh and lagoons, particularly birds that eat emergent aquatic insects and feed them to their young
- potential contamination of birds, mammals, and reptiles from ingestion of contaminated amphibian larvae
- potential PCB contamination of populations and communities of soil-dwelling invertebrates and burrowing vertebrates and subsequent potential contamination of terrestrial wildlife such as birds
- a fence around the site limits access of wildlife; thus onsite exposure of wildlife unlikely

Document Reviewed: Endangerment Assessment; January 19, 1988.

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OLD SPRINGFIELD LANDFILL
SPRINGFIELD, VT
REGION 1

Type of Site: inactive landfill

Major Release Pathways:

- leachate seepage
- ground-water discharge

Principal Contaminants:

- inorganics: Cu, Ni
- organics: PCBs

Media/Biota Observed to be Contaminated:

- ground water
- soil
- sediments

Main Ecological Risks/Impacts:

- potential bioaccumulation of PCBs and subsequent effects to aquatic organisms; chronic effects also possible due to exposure to other contaminants
- the Bald Eagle and American Osprey (Vermont endangered species) pass through the area during migration periods
- potential contamination of terrestrial wildlife from direct contact with or ingestion of contaminated soil, sediments, or water*

- potential for effects to organisms at higher levels in the food chain from consumption of contaminated organisms*

Document Reviewed: Endangerment Assessment Report; June 1988.

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RE-SOLVE, INC.
NORTH DARTMOUTH, MA
REGION 1

Type of Site: inactive waste chemical reclamation facility

Major Release Pathways:

- accidental spills and purposeful oil spreading on soils
- erosion/runoff of residual contaminated soil
- infiltration into ground water from spills and unlined lagoons; ground water discharges into surface water

Principal Contaminants:

- inorganics: Cd, Hg, Fe, As, Mn
- organics: PCBs, methylene chloride, phthalates, toluene, fluoranthene, benzo(a)pyrene, benzo(a)anthracene, 1,2-trans-dichloroethene

Media/Biota Observed to be Contaminated:

- soil
- surface water (stream, river, and pond)
- surface water sediments
- ground water
- fish and eels
- aquatic benthic organisms

Main Ecological Risks/Impacts:

- although a benthic study notes a basic aquatic food chain is intact, there is a potential for sediment contamination to adversely affect benthic organisms and organisms higher in the food chain; in particular there are concerns about potential bioaccumulation of PCBs, especially in birds, with subsequent egg-shell thinning and decreased reproductive success

- creek sediments "highly contaminated" with PCBs to a depth of 1 foot roughly 300 feet downstream
- a small (roughly 0.1 acre) wetland is contaminated, potentially causing adverse effects to organisms that reside there (a variety of birds, amphibians, small mammals, and aquatic invertebrates); the entire wetland is contaminated with more than 1 ppm PCB to a depth of roughly 1.5 feet
- potential chronic toxicity effects to aquatic organisms due to elevated concentrations of Cd, Hg, and volatile organics

Documents Reviewed:

- Technical Memo for Determination of PCB Clean-up Criteria Re-Solve Inc. Site; September 24, 1987.
- Draft Remedial Investigation Report Re-Solve Site Off-Site Investigation; February 1985.
- Draft Preliminary Public Health Evaluation for the Re-Solve Site in North Dartmouth, MA; July 29, 1986.
- ICF Chart on Ecological Threats at Re-Solve Inc. Site; March 1988.
- Preliminary Draft Remedial Investigation Report; November 1986.
- Offsite Investigation Follow Up To Onsite Remedial Investigation/ Feasibility Study; no date.
- Record of Decision; 1987.

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SULLIVAN'S LEDGE
NEW BEDFORD, MA
REGION 1

Type of Site:

- former granite quarry and industrial waste disposal site
- four inactive pits: two filled with automobiles, two used as industrial waste disposal sites

Major Release Pathways:

- seepage into ground water, which discharges to surface water
- surface runoff into surface water

Principal Contaminants:

- inorganics: Pb, Hg, Cu, Zn, Ag
- organics: PCBs, chlorobenzene, pentachlorophenol, bis(2-ethylhexyl)phthalate

Media/Biota Observed to be Contaminated:

- soils
- surface water
- sediments
- ground water

Main Ecological Risks/Impacts:

- potential threats to Apponagansatt Swamp
- only minimal adverse impacts to the forested wetlands were expected

Document Reviewed: Remedial Investigation Report; June 1987.

EPA REGION 2 SITES

CHEMICAL CONTROL
ELIZABETH, NJ
REGION 2

Type of Site: inactive landfill

Major Release Pathways:

- seepage of landfill leachate directly to surface water (river)
- infiltration into ground water, which is observed to discharge to river

Principal Contaminants:

- inorganics: N/A
- organics: volatile organics, phthalate esters, PCBs

Media/Biota Observed to be Contaminated:

- ground water
- river sediments
- soil

Main Ecological Risks/Impacts:

- surface water (river) is polluted, but contamination cannot be linked directly to this site
- 2.2 acres of soil contaminated with organics
- areawide studies conducted by the Fish and Wildlife Service and the Army Corps of Engineers concluded that sensitive species have either been entirely eliminated from the area, or they are present only in particular areas during certain times of the year
- food chain contamination could result if benthic organisms are present in the mouth of the Elizabeth River, especially bioaccumulation of PCBs
- three sensitive areas were identified in a dredging environmental impact assessment by the Army COE: Shooters Island; wetlands near Goethals Bridge; and mudflats in Newark Bay (however, it was concluded that it is unlikely that contaminants in the Elizabeth River could adversely affect any of these areas because of the distance from the site and dilution by the river)

Documents Reviewed:

- Record of Decision; 1987.
- Remedial Investigation (partial); no date.
- Feasibility Study (partial); no date.

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CLOTHIER
GRANBY, NY
REGION 2

Type of Site: inactive privately-owned landfill

Major Release Pathways:

- discharge of leachate-contaminated ground water to surface water
- direct discharge to wetlands from buried drums
- runoff of soil to Creek

Principal Contaminants:

- inorganics: Cd, Cr, Mn, Ba
- organics: bis(2-ethylhexyl)phthalate, 1,2-dichloroethene, tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, xylenes

Media/Biota Observed to be Contaminated:

- ground water
- soil
- sediments (Ox Creek)
- surface water -- below AWQC levels

Main Ecological Risks/Impacts:

- 6 acres of soil contaminated with organics and metals
- Ox Creek and a New York State designated freshwater wetland adjacent to Ox Creek border the onsite waste disposal area; Three Rivers State Wildlife Management Area is located 3 miles from the site
- degradation of wetlands habitat from potential dredging of contaminants
- potential for bioaccumulation and other chronic effects to benthic organisms from contaminated sediments*

- potential for acute toxic effects to aquatic organisms from runoff of soil and leachate into Ox Creek during recommended excavation of onsite contaminated soil

Document Reviewed: Public Health Evaluation; June 15, 1988.

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HUDSON RIVER
GLEN FALLS, NY
REGION 2

Type of Site: PCB-contaminated river

Major Release Pathways:

- discharge of PCBs into river
- sediment release to water column
- PCBs present in dredge spoils located along the river banks (i.e., in the floodplain)
- PCBs leaching via ground water
- air volatilization of PCBs
- potential erosion and re-suspension of contaminated soils and sediment during the future remedial activities

Principal Contaminants: PCBs (arochlors 1221, 1254, 1016, and perhaps others)

Media/Biota Observed to be Contaminated:

- soil
- river sediments
- surface water
- ground water
- air
- fish
- onsite vegetation

Main Ecological Risks/Impacts:

- potential toxic effects to terrestrial biota and aquatic biota other than fish; other effects due to the potential bioaccumulation of PCBs*
- tidal estuary in lower 150 miles of river and some wilderness areas contaminated

Documents Reviewed:

- HRS Panel Summary Risk Assessment for Hudson River; June 1987.
- ICF Chart on Ecological Threats at Hudson River Site; March 1988.
- Feasibility Study Vol. 1; April 1984.
- Draft Environmental Impact Statement; May 1981.
- Final Environmental Impact Statement; January 1987.
- Hudson River PCB Contamination - A 1985 Perspective.
- Contaminants in Hudson River Striped Bass: 1978-1985 (86 supplement).
- PCB Contamination data (tables).

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LIPARI LANDFILL
MANTUA TOWNSHIP, NJ
REGION 2

Type of Site: inactive landfill

Major Release Pathways:

- direct release of drummed wastes through spillage
- leaching of ground water to surface pools and then to marsh or directly to Chestnut Branch
- flooding of Alcyon Lake and release of contaminants to soils (frequency of flooding not indicated)

Principal Contaminants:

- inorganics: Zn, Cr, Ni, Pb, Hg, As
- organics: benzene, 1,2-dichloroethane, ethylbenzene, toluene, bis(2-chloroethyl)ether, xylene, chloroform

Media/Biota Observed to be Contaminated:

- soil in marsh and parks
- ground water
- surface water (Rabbit Run, Chestnut Branch, Alcyon Lake)
- sediments (Rabbit Run, Chestnut Branch, Alcyon Lake)
- vegetation
- fish

Main Ecological Risks/Impacts:

- complete devastation of vegetation in leachate migration paths
- 1,500 feet of stream surface water contaminated with bis(2-chloroethyl)ether, toluene, arsenic, chromium, mercury, and lead
- 26 acres of lake surface water and sediment contaminated
- 700′ x 200′ area of marsh soil contaminated with organics and metals
- bioaccumulation of organics in fish
- potential reduction in species diversity in Alcyon Lake; common carp is most populous fish and constitutes greatest total biomass; this species is known to be tolerant of poor water quality
- potential chronic effects to fish in Alcyon Lake, such as stunted growth
- potential contamination of benthic organisms in streams due to contaminated sediments, and possible contamination of organisms at higher trophic levels
- potential contamination of and toxic effects to terrestrial wildlife from direct ingestion of contaminated media or through the food chain (e.g., raccoons, opossum, water fowl)
- the marsh area, streams, and parks adjacent to Alcyon Lake are considered important and sensitive environments by the State of New Jersey

Documents Reviewed:

- Offsite Remedial Investigation Final Draft; June 1987.
- Onsite Feasibility Study; August 1985.
- Risk Assessment (Appendix A of RI); June 1987.
- Public Health Evaluation; June 1987.

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MARATHON BATTERY CORPORATION
PUTNAM CO., NY
REGION 2

Type of Site: inactive battery production facility

Major Release Pathways: Ni-Cd waste effluent from battery plant was discharged through a storm sewer into a cove and two freshwater marsh areas

Principal Contaminants:

- inorganics: Cd, Ni, Co, nitrate, carbonate
- pH (basic: 11-12.5)

Media/Biota Observed to be Contaminated:

- sediment
- surface water
- onsite soils
- fish, shellfish, benthic invertebrates
- reptiles (turtles)
- mammals
- marsh vegetation

Main Ecological Risks/Impacts:

- marsh sediments contaminated up to 2 miles from the battery plant
- sensitive environments contaminated: two freshwater marsh areas of 284 acres, and a tidal flat and cove of 34 acres
- marsh and wetlands could be disturbed further by remedial action
- potential effects to fish which use the wetlands for spawning*
- ecological effects described as "minimal" and minor
- potential threats to terrestrial biota*

Documents Reviewed:

- ICF Chart on Ecological Threats at Marathon Battery Site (Only Area I: Constitution Marsh and East Foundry Cove); March 1988.
- Record of Decision, Remedial Alternative Selection for Marathon Battery Company Site Area I; 1986.
- Draft Remedial Investigation Report; April 1988.

EPA REGION 3 SITES

ARMY CREEK LANDFILL
NEW CASTLE, DE
REGION 3

Type of Site:

- abandoned sand and gravel pit
- pit used as a primary disposal site for municipal and industrial wastes

Major Release Pathways:

- infiltration into ground water and migration to potable water sources (potential human health concern)
- ground-water collection system directly discharges untreated water into Army Creek

Principal Contaminants:

- inorganics: Fe, Mn, Cr, Be, Cd, Pb, Ni, Zn, As
- organics: benzene; 1,2-dichloropropane; methyl chloride; 2,4-dinitrotoluene; N-nitrosodimethylamine; 1,2-dichloroethane; bis(2-chloroethyl) ether; 2,4,6-trichlorophenol; chlorodibromomethane

Media/Biota Observed to be Contaminated:

- ground water
- sediment
- actual biota contaminated include: vegetation, fish, benthic macroinvertebrates, snails, fingernail clams

Main Ecological Risks/Impacts:

- low diversity of benthic species observed
- "damage to flora where leachate seeps from landfill"
- "recent photographs ... show normal vegetative cover with no signs of environmental stress"
- potential effects on aquatic biota include mortality, reduction in reproductive success, and diversity and weight loss
- bioassays indicate that change has occurred in the surface water but

the severity of impacts on aquatic life are "not readily discernable"

Documents Reviewed:

- Endangerment Assessment; July 1984.
- Feasibility Study; July 1986.
- Record of Decision - Remedial Alternative Selection; September 30, 1986.

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CHISMAN CREEK
YORK COUNTY, VA
REGION 3

Type of Site: four abandoned sand and gravel pits that were filled with flyash from electric power generating station (they are now surface water ponds)

Major Release Pathways:

- surface water runoff into tributaries and creek
- discharge of contaminated ground water into creek

Principal Contaminants:

- inorganics: As, Cd, Cu, Pb, Ni, Se, V, Zn
- organics: N/A

Media/Biota Observed to be Contaminated:

- ground water

Ponds

- vegetation
- surface water
- sediments
- fish

Chisman Creek

- surface water
- sediments

- benthic community (especially oysters)

Main Ecological Risks/Impacts:

General

- four freshwater ponds (13.5 acres, 4.5 acres, 12.9 acres, and 5 acres) contaminated with metals
- the site is a nesting area for protected bird species (e.g., osprey), and a heron rookery is 2.5 miles from the site; a national wildlife refuge is 7 miles downstream of the site

Ponds

- surface water exceeds AWQC for lead and vanadium
- arsenic, copper, cadmium, lead, and selenium are being bioaccumulated by fish in the freshwater ponds
- potential for other chronic effects to fish from sediment and surface water contamination, including respiration and osmo- regulation effects
- contamination of birds using ponds for feeding may occur, as well as terrestrial wildlife*
- potential contamination effects to terrestrial wildlife from ingestion of vegetation with elevated metals concentrations*

Chisman Creek

- bioaccumulation of metals in oysters has occurred, and is likely to occur in other benthic organisms
- potential for bioaccumulation and possible toxic effects to other aquatic organisms, and organisms higher in the food chain such as birds that use the area for nesting and feeding, and terrestrial organisms

Document Reviewed: Remedial Investigation/Endangerment Assessment of the Environmental Impacts, Vol. I and II; September 1987.

DELAWARE SAND AND GRAVEL LANDFILL
NEW CASTLE COUNTY, DE
REGION 3

Type of Site: inactive industrial waste landfill

Major Release Pathways:

- discharge of ground water recovery wells into Army Creek (wells in operation for 12 years)
- leachate seepage into creek
- contaminated ground-water discharge to creek

Principal Contaminants:

- inorganics: Fe, Mn, Mg, Ba, Cr, Zn
- organics: N/A

Media/Biota Observed to be Contaminated:

- surface water -- Army Creek and Army Creek Pond
- soil
- creek sediments
- ground water
- benthic organisms in Army Creek

Main Ecological Risks/Impacts:

- Army Creek Pond is eutrophic with low species diversity and a high percentage of pollution-tolerant organisms
- 12.5 acres of soil are contaminated with various metals
- the number and variety of benthic organisms present in Army Creek are reduced
- potential for bioaccumulation of metals detected in surface water and sediments in aquatic organisms, vegetation, and waterfowl associated with the nearby Delaware River*
- potential contamination of wetlands habitat*

Documents Reviewed:

- Remedial Investigation; December 29, 1987.
- Record of Decision; 1988.

DOUGLASSVILLE DISPOSAL SITE
BERKS COUNTY, PA
REGION 3

Type of Site:

- former waste oil recycling and refining facility with onsite lagoons and storage areas
- currently an active waste oil reprocessing facility

Major Release Pathways:

- migration of contaminants from former lagoons, sludge impoundments, and drum storage area via surface water runoff, flood events, and sediment transport in a drainage ditch at the site
- direct discharge from waste water treatment system of active facility

Principal Contaminants:

- inorganics: Pb
- organics: PCBs, toluene, benzene, tetrachloroethene

Media/Biota Observed to be Contaminated:

- surface water
- ground water
- sediments
- fish

Main Ecological Risks/Impacts:

- potential impacts to aquatic and terrestrial biota indigenous to the rural and riparian areas*
- toxicity and mortality observed in biota
- sensitive environments potentially affected: the Schuylkill River (a state scenic river), a historic site and state park, and riparian wetlands*

Documents Reviewed:

- Remedial Investigation/Feasibility Study; June 1986.
- Record of Decision; September 27, 1985.

L.A. CLARKE AND SON, INC.
SPOTSYLVANIA, VA
REGION 3

Type of Sites:

- active wood treating company
- five waste pits containing creosote wastes

Major Release Pathways:

- sediment and surface water discharge into major onsite ditches that flow into offsite wetlands
- potential leaking underground storage tanks, not in use

Principal Contaminants:

- inorganics: N/A
- organics: polynuclear aromatic hydrocarbons, benzene

Media/Biota Observed to be Contaminated:

- surface soils
- surface water
- ground water
- sediments
- fish
- vegetation

Main Ecological Risks/Impacts:

- several "stressed" vegetation areas less than 1 acre in size
- deformities and cancerous growths in local fish
- acute toxic effects observed in bioassays using daphnia and minnows
- sensitive areas affected include wetlands, ponds
- other contaminated areas of concern include creeks, tributaries, wooded areas, and brush areas

Documents Reviewed:

- Bioassessment Studies; January 1988.
- Work Plan for Remedial Investigation/Feasibility Study; November 1, 1985.

- Final Remedial Investigation/Feasibility Study; February 9, 1988.
- Record of Decision; March 31, 1988.

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NEW CASTLE STEEL
NEW CASTLE, DE
REGION 3

Type of Site: open, partially inactive dumping area for steel foundry wastes

Major Release Pathways:

- surface water runoff/erosion into nearby marsh (tidal estuary) on edge of Delaware River
- seepage into ground water, which may discharge to marsh (this pathway was not investigated)
- mobilization of Pb particulate into air, with possible deposition of particulate in marsh

Principal Contaminants:

- inorganics: Pb (primarily); also As, Cd, Cr, Ni
- organics: N/A

Media/Biota Observed to be Contaminated:

- soil
- sediment (in marsh)
- surface water (in marsh)

Main Ecological Risks/Impacts:

- "diminished habitat quality" of marsh noted
- potential for adverse effect on habitat and species of two National Wildlife Refuges on the opposite side of the Delaware River, including some endangered species and their habitat
- potential for inhibited growth and reproduction of aquatic species in marsh due to Pb contamination and bioaccumulation
- Pb levels in samples of marsh surface water exceeded chronic AWQC by 2X; one sample on edge of marsh (next to land) exceeded acute AWQC by 3X
- actual site contamination covers about 3 acres; marsh, which has potential for adverse effect on species, covers about 40 acres

Documents Reviewed:

- Final Endangerment Assessment; May 4, 1988.
- Record of Decision; March 31, 1988.

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PALMERTON ZINC
PALMERTON, PA
REGION 3

Type of Site: active zinc smelter

Major Release Pathways:

- water flowing across the defoliated mountain carries metal-laden soil into surface water
- air emissions

Principal Contaminants:

- inorganics: Cd, Zn, Pb
- organics: N/A

Media/Biota Observed to be Contaminated:

- soil
- surface water
- ground water
- vegetation
- fish
- microflora (bacteria)
- lichens
- arthropods
- amphibians

Main Ecological Risks/Impacts:

- 2,000 acres on Blue Mountain completely defoliated
- absence of microflora in the affected area; trees that fell 10-20 years ago have not decayed
- richness and abundance of lichen species reduced by approximately 90%
- total arthropod density approximately 22% of that of uncontaminated area

- inhibited seed germination
- absence of earthworms, slugs, snails, toads and salamanders
- elevated metal concentration in fish
- potential habitat shift due to defoliation of Blue Mountain*
- cadmium, lead, and zinc concentrations in soils up to 2600X, 2000X, and 400X background levels, respectively; surface water run-off exceeds AWQC for these metals by 1-25X
- potential contamination of and toxic effects to offsite terrestrial wildlife from contact with or ingestion of contaminated soil or vegetation, or from air emissions*
- potential contamination of surface water sediments, benthic organisms, and organisms at higher trophic levels (e.g., birds)*

Documents Reviewed:

- Declaration for the Record of Decision and Site Description and Summary of Remedial Alternative Selection for the Palmerton Zinc Superfund Site - Blue Mountain Operable Unit; September 4, 1987.
- Record of Decision; 1987.
- Remedial Investigation; April 1987.

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TYBOUTS CORNER LANDFILL
NEW CASTLE, DE
REGION 3

Type of Site:

- inactive municipal and sanitary landfill
- received industrial wastes from 1968 to 1971

Major Release Pathways:

- ground-water migration of percolated contaminants
- leachate from site enters streams and marshes surrounding the site

Principal Contaminants:

- inorganics: N/A
- organics: vinyl chloride, 1,2-dichloroethane, trichloroethylene, benzene

Media/Biota Observed to be Contaminated:

- ground water (2 aquifers)
- surface water
- sediments
- vegetation

Main Ecological Risks/Impacts:

- "vegetative stress" observed at point of leachate discharge in Red Lion Marsh
- "potential deterioration of the ecology of Red Lion Marsh is a concern at this site"
- concentrations of contaminants in surface water and sediments "are not sufficient to threaten human health and the ecological environment"
- potential impacts to Pigeon Run wetland, and terrestrial and aquatic fauna*

Document Reviewed: Remedial Investigation/Feasibility Study Report; June 1985.

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TYSON'S DUMP
MONTGOMERY COUNTY, PA
REGION 3

Type of Site:

- an abandoned septic and chemical waste disposal site
- several unlined lagoons constructed within an old sandstone quarry

Major Release Pathways:

- seepage into ground water; leachate from the site is observed to enter the creeks and marshes surrounding the dump
- potential erosion and surface runoff

Principal Contaminants:

- inorganics: N/A
- organics: benzene, di-n-butyl phthalate, 1,2-dichlorobenzene, 4-methylphenol, tetrachloroethene, 1,2,4-trichlorobenzene, trichloroethene, 1,2,3-trichloropropane, o-xylene

Media/Biota Observed to be Contaminated:

- ground water
- surface water
- soils
- air

Main Ecological Risks/Impacts:

- "it can be concluded that trichloropropane has migrated offsite to the floodplain area and then to the Schylkill River"
- potential habitats affected include creeks, the Schylkill River, floodplain areas, small ponds, and a swamp, all within approximately 800 ft. of the site*
- "the site appears to support a diverse and unimpacted flora and associated fauna" (Fish and Wildlife Service site investigation)

Documents Reviewed:

- HRS Panel Risk Assessment; June, 1987.
- Risk Assessment of the Tyson's Dump Site, Final Report; no date.
- Final Remedial Investigation Report; July 1985.
- Off-site Operable Unit Remedial Investigation Report; December 8, 1986.

WEST VA ORDNANCE WORKS
MASON COUNTY, WV
REGION 3

Type of Site: former TNT manufacturing facility

Major Release Pathways:

- accidental spills to soil
- erosion/runoff of residual contaminated soil
- infiltration into ground water, which discharges to surface water and surface seeps along escarpment
- direct discharge to surface water

Principal Contaminants:

- inorganics: Pb, asbestos

- organics: 2,4,6-trinitrotoluene, 2,4-dinitrotoluene, 1,3,5-trinitrobenzene, PAHs

Media/Biota Observed to be Contaminated:

- soil (on surface and underground along sewer lines)
- surface water (river)
- surface water sediments
- ground water
- vegetation

Main Ecological Risks/Impacts:

- vegetation killed over roughly 1 acre due to nitroaromatic contamination; vegetation growth "inhibited" on roughly 2-3 additional acres
- entrapment of animals by falling into open manholes (numerous mammal skeletons were observed in manholes)
- potential for "limited" occurrences of acute toxic effects to or explosion of terrestrial wildlife that come into direct contact with concentrated chunks of TNT; proportion of terrestrial population likely affected is less than 2-5 percent
- roughly 60 acres of the State-operated McClintic Wildlife Station now located onsite is contaminated to varying degrees; the wildlife station (which is made up of a total of 2,800 acres) contains 39 impoundments developed for propagation of fish and waterfowl
- potential for acute toxicity to aquatic life caused by erosion during storm events; no toxic effects to aquatic life expected normally because water concentrations below available toxicity criteria
- 8 endangered species potentially occur in wildlife station, but none have been sighted

Documents Reviewed:

- Remedial Investigation; September 1985.
- Feasibility Study for the TNT Manufacturing Area, The Burning Grounds and The Industrial Sewerlines; October 1986.
- Supplemental Remedial Investigation; November 1986.
- Endangerment Assessment for Sewerlines, The TNT Manufacturing Area and The Burning Grounds; April 1986.
- Endangerment Assessment for Acids Area/Yellow Water Reservoir, Red Water Reservoirs, and the Pond 13/West Well Area; December 1986.
- Summary of Remedial Investigation/Feasibility Study (from draft FY 87 CERCLA Report to Congress).
- Record of Decision; March 31, 1987.

WILDCAT LANDFILL
DOVER, DE
REGION 3

Type of Site: inactive landfill

Major Release Pathways:

- direct release and spreading of drummed wastes on soil and in marshes
- leachate seepage to surface water
- discharge of contaminated ground water to surface water

Principal Contaminants:

- inorganics: Ba, Ni, Pb, Zn
- organics: N/A

Media/Biota Observed to be Contaminated:

- fish
- painted turtles
- vegetation
- ground water
- onsite pond water
- onsite pond sediments
- soil

Main Ecological Risks/Impacts:

- increased incidence of lesions and gill inflammation in fish in onsite pond
- bioaccumulation of metals in painted turtles and in fish in onsite pond
- degradation and loss of wetlands habitat (29 acres)
- barren patches void of any vegetation
- bald eagle has been sighted near the landfill, and 6 species of plants at the site are listed in a rare plant draft list for the State of Delaware
- potential bioaccumulation of PCBs and metals in river fish
- potential contamination of benthic organisms and subsequent contamination of organisms at higher trophic levels from ingestion*
- access to site by wildlife is not restricted

Documents Reviewed:

- Remedial Investigation; May 1988.
- Record of Decision; June 29, 1988.

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WINCHESTER TIRE FIRE
FREDERICK COUNTY, VA
REGION 3

Type of Site: inactive tire disposal company

Major Release Pathways:

- acute: a plume of black smoke 3000 ft. high and 30-50 miles long emitted as a result of the tire fire; runoff and percolation of pyrolyzed liquids containing hazardous organic compounds
- ground water flows through overburden and highly fractured bedrock towards an intermittent stream
- surface runoff of contaminated burn rubble and ash
- two onsite ponds, one is unlined and potentially causing ground-water contamination

Principal Contaminants:

- inorganics: Al, Cu, Pb, Ag, Zn
- organics: alpha BHC, benzoic acid, bis(2-ethylhexl)phthalate, 4-methylphenol, toluene

Media/Biota Observed to be Contaminated:

- soil
- sediments
- surface water
- ground water
- fish
- benthic invertebrates

Main Ecological Risks/Impacts:

- acute: an undetermined quantity of hot oil (produced from the melting and pyrolysis of tires) flowed into Hogue Creek, which is part of the Potomac River System

- acute and chronic toxic effects to daphnia and minnows "probably due to copper, lead, silver, and zinc: average and maximum concentrations of these metals exceeded AWQC"

Documents Reviewed:

- Management of Migration of Contamination Via Surface Water; May 1988.
- Remedial Investigation/Feasibility Study; March 1987.

EPA REGION 4 SITES

AMERICAN CREOSOTE WORKS, INC.
PENSACOLA, FL
REGION 4

Type of Site: inactive wood preserving operation

Major Release Pathways:

- unlined surface impoundments are below normal water table
- liquid wastes allowed to overflow into area drainage ways

Principal Contaminants:

- inorganics: N/A
- organics: PAH's, benzene, toluene, xylene, ethylbenzene, and other VOCs

Media/Biota Observed to be Contaminated:

- ground water
- soils
- surface water
- sediments

Main Ecological Risks/Impacts:

- contaminant plume moving toward bay and bayou
- "bioaccumulation may occur [in marine biota] in the short term, but the PAH's in general are eliminated through metabolism and excretion [which] . . . precludes biomagnification up food chain"
- long-term, adverse impacts may occur to terrestrial fauna which consume contaminated ground water

Documents Reviewed:

- Remedial Investigation Report; January 1985.
- Record of Decision; September 30, 1985.
- Feasibility Study Report; April 1986.

58TH STREET LANDFILL
TAMPA, FL
REGION 4

Type of Site: inactive landfill containing lead-cadmium batteries

Major Release Pathways:

- sediment transport
- surface water runoff
- soil contaminants leaching to ground water

Principal Contaminants:

- inorganics: Pb, Cd, Sb, Cu, Fe, Zn, As
- pH

Media/Biota Observed to be Contaminated:

- surface water
- marsh sediments
- surface and subsurface soils
- shallow groundwater aquifer

Main Ecological Risks/Impacts:

- potential impacts to scrub-shrub palustrine wetland vegetation
- potential impacts to wetland and urban wildlife

Documents Reviewed:

- Remedial Investigation Report; May 8, 1987.
- Risk Assessment; June 7, 1987.
- Final Feasibility Study Report; June 7, 1987.
- ATSDR Health Assessment; July 7, 1988.

GEIGER (C&M OIL)
CHARLESTON COUNTY, SC
REGION 4

Type of Site:

- inactive waste oil recycling and incineration facility
- inactive waste oil disposal ponds

Major Release Pathways:

- overflow from ponds onto land and into water ponds, surrounding wetlands, and stream (during storm events)
- seepage from ponds into ground water, which may discharge to surrounding wetlands

Principal Contaminants:

- inorganics: Pb, Cr, Hg
- organics: VOCs, PCBs

Media/Biota Observed to be Contaminated:

- soil (surface and subsurface)
- surface water (ponds; a stream)
- sediment (stream; wetlands)
- ground water

Main Ecological Risks/Impacts:

- potential contamination of nearby Wallace River wetlands (endangered species habitat) due to migration of contaminated ground water
- potential contamination of wildlife that visit or reside in the Wallace River wetlands or in the immediate area of the site
- area of soil contamination ~2.6 acres
- area of ground-water contamination ~4.1 acres
- Pb and Cr concentrations in soil exceed concentrations known to be phytotoxic
- maximum Pb surface water concentration exceeds 4-day average AWQC by 14X
- maximum Cr surface water concentration exceeds 4-day average AWQC by 3X

Documents Reviewed:

- Summary of Remedial Investigation/Feasibility Study (from draft FY 87 CERCLA Report to Congress).
- Record of Decision; June 1, 1987.
- Remedial Investigation Report, (including PHE); July 1, 1986.
- Feasibility Study; July 24, 1987.

HARRIS CORP.
PALM BAY, FL
REGION 4

Type of Site: active manufacturing facility

Major Release Pathways: NPDES-permitted discharge of ground water treated with air stripper

Principal Contaminants:

- inorganics: As, Cr, Pb
- organics: VOCs

Media/Biota Observed to be Contaminated:

- onsite soil
- ground water

Main Ecological Risks/Impacts:

- potential contamination of benthic organisms in Turkey Creek due to possible contamination of sediments by metals, especially in the treated ground-water discharge area*
- potential effects to aquatic organisms from discharge of treated ground water with possible low levels of contamination

Documents Reviewed:

- Groundwater Studies; March-October 1982.
- Analysis of Potential Groundwater Withdrawal and Treatment Systems; March 8, 1983.
- Soil and Sediment Investigation; March 1984.
- Old Storm Sewer Investigation; May 1984.

- Groundwater Remediation Program; August 15, 1985.
- Groundwater Assessment; November 1987.

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MOWBRAY ENGINEERING
GREENVILLE, AL
REGION 4

Type of Site:

- inactive transformer repair facility
- inactive dumping area for waste oils and PCBs
- contaminated swampland adjacent to facility

Major Release Pathways:

- surface runoff/erosion from swampland into nearby stream
- seepage from swampland into ground water, which discharges to stream

Principal Contaminants:

- waste oils
- PCBs

Media/Biota Observed to be Contaminated:

- soil (surface and subsurface)
- sediment (of stream)
- ground water
- vegetation
- aquatic life of stream

Main Ecological Risks/Impacts:

- stressed vegetation in swampland (one plant analyzed for PCB contamination in root tissue; contamination was found)
- effect on aquatic life in stream (after 1980 overflow of facility holding tanks, stream found to be devoid of aquatic life for 2.5 miles downstream; later, catfish analyzed for PCB contamination, which was found to be below FDA action level for human health protection)
- potential mortality and decreased reproductive success of birds and fish due to bioaccumulation of PCBs
- swampland contamination about 3 acres in size

Documents Reviewed:

- Record of Decision; September 25, 1986.
- Remedial Investigation/Feasibility Study Work Plan; June 25, 1985.
- Final Remedial Investigation/Feasibility Study Report (including PHE); November 3, 1986.
- Determination of Cleanup Goals for PCBs in Soils; July 10, 1986.

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MUNISPORT LANDFILL
NORTH MIAMI, FL
REGION 4

Type of Site: inactive landfill

Major Release Pathways: migration of landfill contaminants via subsurface leachate and groundwater transport

Principal Contaminants:

- inorganics: primarily Pb, ammonia
- organics: pesticides, volatile organics
- low dissolved oxygen

Media/Biota Observed to be Contaminated:

- ground water
- soil
- surface water
- fish
- aquatic invertebrates

Main Ecological Risks/Impacts:

- actual mortality and toxicity in aquatic biota
- potential effects to biota include: behavioral changes, adverse effects on reproduction, decreased growth, hyperexcitability, loss of equilibrium, inhibition of photosynthesis
- potential sensitive environments affected: mangrove preserve, wetlands, an estuary, habitat for endangered, threatened, or protected species (e.g., 4 species of sea turtle, the west indian

manatee, the wood stork, and the bald eagle), and the Biscayne Aquifer

Document Reviewed:

- Remedial Investigation Report; March 25, 1988.

NEWPORT DUMP
WILDER, KY
REGION 4

Type of Site: inactive municipal landfill

Major Release Pathways: seepage of contaminants into ground water, and potential discharge of contaminated ground water to adjacent stream and river

Principal Contaminants:

- inorganics: As, Ba, Cr, Ni
- organics: PCBs (primarily); also, benzo(a)pyrene, toluene

Media/Biota Observed to be Contaminated:

- soil
- surface water (of stream and river)
- sediment (of stream and river)
- ground water
- fish

Main Ecological Risks/Impacts:

- occasional exceedance of FDA human health-based tolerance limits for PCBs in fish tissue (not conclusively linked to this site due to heavy industrialization in area)
- noted unhealthiness of fish downstream (also not conclusively linked to this site)
- no exceedances of Clean Water Act Freshwater Aquatic Life Criteria, similar Kentucky criteria, and other toxicity values (for invertebrates, coarse fish, and game fish) for indicator chemicals
- potential risk to endangered species whose ranges overlap site area
- potential risk to birds of prey due to potential for bioaccumulation of PCBs in surface soils

- site is about 39 acres in size; contamination beyond site boundaries judged negligible and not conclusively linked to Newport Dump site

Documents Reviewed:

- Summary of Remedial Investigation/Feasibility Study (from draft FY 87 CERCLA Report to Congress).
- Record of Decision; March 27, 1987.
- Draft Remedial Investigation/Feasibility Study Report, Vol. I and Vol. II; September 1986.
- Final Remedial Investigation/Feasibility Study Report, Vol. I and Vol. III (appendices); March 1987.
- Final Endangerment Assessment; January 1987.

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PARRAMORE SURPLUS CO.
MT. PLEASANT, FL
REGION 4

Type of Site: active government surplus store

Major Release Pathways:

- leaking drums of paint residue, waste oil, degreasers, alcohols
- limited migration, onsite only

Principal Contaminants:

- inorganics: Pb, Zn
- organics: PCB-1254, bis(2-ethylhexl)phthalate, di-n-butylphthalate, ethylbenzene, methyl ethyl ketone, and cyanide

Media/Biota Contaminated:

- soil
- vegetation onsite

Main Ecological Risks/Impacts:

- no ecological impacts expected
- potential for area wildlife contamination is limited to direct contact with soils and ingestion of vegetation onsite

Documents Reviewed:

- Summary of Remedial Investigation/Feasibility Study (from draft FY 87 CERCLA Report to Congress).
- Record of Decision; September 15, 1987.
- Modified Remedial Investigation Report; January 1986.

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SAPP BATTERY
JACKSON COUNTY, FL
REGION 4

Type of Site: inactive battery reconditioning and battery lead (Pb) recovery facility

Major Release Pathways:

- surface runoff into surrounding cypress swamps and into streams and a pond
- possible contamination of swamps and streams by horizontal migration of contaminated ground water from underneath site*

Principal Contaminants: Pb (primarily), Cd, Al, As, Sb, Mn, Ni

Media/Biota Observed to be Contaminated:

- air (sampled during remediation)
- surface water
- soil (surface and subsurface)
- sediment (pond and streams)
- ground water
- fish in river (Pb contamination)

Main Ecological Risks/Impacts:

- loss of species, and reduced species numbers, diversity, and dominance in benthic stream fauna
- Pb contamination in river fish
- death of cypress trees
- site is 53 acres in size, study area covers about 460 acres; contamination virtually throughout site, and in undefined areas beyond site
- potential risks to endangered species in vicinity of site*

Documents Reviewed:

- Record of Decision; September 26, 1986.
- Final Remedial Investigation Report, January 20, 1984.
- Feasibility Study Report; January 1987.
- Scope of Work for Remedial Action Support; May 24, 1988.

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62ND STREET SITE
TAMPA, FL
REGION 4

Type of Site: abandoned industrial waste disposal dump

Major Release Pathways: leaching of concrete material and battery casing waste to adjacent commercial fish ponds

Principal Contaminants:

- inorganics: Cu, Fe, Pb, Zn
- organics: detergents
- turbidity
- low dissolved oxygen
- high B.O.D.

Media/Biota Observed to be Contaminated:

- ground water
- soil
- fish

Main Ecological Risks/Impacts:

- potential contaminant bioaccumulation in fish
- severe fish kills reported in adjacent commercial fishery
- potential contamination of and adverse effects to "marshy grass" and a 37 acre lake approximately a quarter of a mile from the site*

Document Reviewed: Revised Remedial Investigation Report; September 10, 1987.

STAUFFER CHEMICAL COMPANY
AXIS, AL
REGION 4

Type of Site: two adjacent chemical production facilities

Major Release Pathways:

- process wastes were discharged to a nearby stream and swamp that adjoins the Mobile River
- 10,000 gallon spill of carbon tetrachloride
- potential seepage into ground water from unlined landfill, ponds, and disposal areas

Principal Contaminants:

- inorganics: Hg, As, Cr
- organics: carbon tetrachloride, carbon disulfide
- brine

Media/Biota Observed to be Contaminated:

- sediments and surface water in swamp
- fish
- vegetation

Main Ecological Risks/Impacts:

- "severe ecosystem damage to endangered species habitat"
- Cold Creek swamp received effluent consisting of 10 ppm of Hg for more than 15 years
- sensitive environments affected include LeMoyne Swamp and Cold Creek Swamp

Documents Reviewed:

- ICF Chart on Ecological Threats at Stauffer Chemical Company Site; March 1988.
- Summary Data for HRS Scoring at Stauffer Chemical Company; June 4, 1987.
- Final Remedial Investigation Report; May 1988.

EPA REGION 5 SITES

EAU CLAIRE MUNICIPAL WELL FIELD
EAU CLAIRE, WI
REGION 5

Type of Site: municipal drinking water well field (ground water) contaminated by unknown sources

Major Release Pathways: possible seepage of ground-water contaminants into the Chippewa River (if pumping of ground water stops)

Principal Contaminants: 1,1-dichloroethane, 1,1-dichloroethene, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene

Media/Biota Observed to be Contaminated: ground water

Main Ecological Risks/Impacts:

- potential for acute and chronic toxic effects on aquatic life in river (fish, invertebrates, reptiles, amphibians) if pumping of ground water stops
- potential risk to waterfowl and terrestrial mammals from ingestion of and contact with stream water, as well as ingestion of potentially contaminated biota, despite tendencies of contaminants to volatilize rapidly and to not bioaccmulate*
- ecological risk from above-ground sources of ground-water contamination (these sources have not been positively identified)*
- area of contamination is not known

Documents Reviewed:

- Public Health Evaluation; February 26, 1988.
- Public Comment Draft Remedial Investigation Report (Performance of Remedial Response Activities at Uncontrolled Hazardous Waste Sites); February 26, 1988.
- Draft Feasibility Study Report; February 11, 1988.

FORT WAYNE REDUCTION
FORT WAYNE, IN
REGION 5

Type of Site: inactive landfill

Major Release Pathways:

- contaminated ground-water/leachate discharge to river
- surface water runoff to river
- flooding (area of river adjacent to site floods fairly frequently)

Principal Contaminants:

- inorganics: As, Cd, Cu
- organics: toluene, xylene, 2,4-methylphenol, phenol

Media/Biota Observed to be Contaminated:

- ground water
- river sediments
- onsite soil

Main Ecological Risks/Impacts:

- 35 acres of soil contaminated with organics and metal
- potential for acute effects to aquatic organisms in area where leachate seeps into river, especially benthic organisms with a small range of movement; leachate concentrations exceed derived acute safety levels for some organics and inorganics
- potential for bioaccumulation and possible toxic effects to benthic organisms from contaminated sediments, and subsequent contamination of organisms higher in the food chain*
- potential contamination and chronic toxic effects to fish due to contaminants in surface water (which are below AQWC; however, fish with lesions and tumors have been reported from the Maumee River, but cannot be linked directly to this site)*
- potential contamination of and toxic effects to terrestrial wildlife and waterfowl near the site from direct ingestion of contaminated media or through the food chain; area is "rich with wildlife due to minimal human access and disturbance"*
- potential contamination of offsite surface water

Document Reviewed: Remedial Investigation Report; January 7, 1988.

FULTZ LANDFILL
BYESVILLE, OH
REGION 5

Type of Site: inactive landfill

Major Release Pathways:

- contaminated ground water and leachate seepage (abandoned coal mine tunneling system is filled with infiltrated contaminated ground water)
- soil erosion
- surface water runoff

Principal Contaminants:

- inorganics: Cd, Cr, Cu, Fe, Pb, Ni, Zn, Mn, As
- organics: cyanide, chloroform, chlordane, 4,4'-DDT

Media/Biota Observed to be Contaminated:

- ground water
- sediments -- Wills Creek

Main Ecological Risks/Impacts:

- potential contamination and toxic effects to benthic organisms in Wills Creek from exposure to contaminated sediments, and subsequent contamination of organisms higher in the food chain*

Documents Reviewed:

- Public Health Evaluation/Risk Assessment; March 11, 1988.
- Remedial Investigation; October 1987.

LIQUID DISPOSAL INC.
UTICA, MI
REGION 5

Type of Site: inactive commercial incinerator of liquid waste

Major Release Pathways:

- erosion of lagoon caps
- leachate seeps from the site

Principal Contaminants:

- inorganics: Pb, Cd
- organics: PCBs, trichloroethene, PAHs, benzene, toluene, phenol, cyanide, and pesticides

Media/Biota Observed to be Contaminated:

- onsite and offsite soil
- ground water in upper aquifer
- vegetation
- crayfish
- carp

Main Ecological Risks/Impacts:

- acute mortality in biota
- other potential acute and chronic toxic effects
- "inorganics and PCBs appear to have bioconcentrated in certain fish" with little impact
- sensitive environments affected: the Clinton River, a nature study area, and a recreation area

Documents Reviewed:

- Summary of Remedial Investigation/Feasibility Study (from draft FY 87 CERCLA Report to Congress).
- Record of Decision; September 30, 1987.
- Remedial Investigation; May 1987.
- Final Draft Feasibility Study; August 1987.

MARION/BRAGG LANDFILL
MARION, IN
REGION 5

Type of Site:

- inactive landfill containing industrial and municipal refuse
- formerly a sand and gravel quarry

Major Release Pathways:

- leachate seeps
- surface water runoff

Principal Contaminants:

- inorganics: As, ammonia
- organics: PAHs

Media/Biota Observed to be Contaminated:

- surface soil
- onsite and offsite ponds (surface water and sediments)
- ground water

Main Ecological Risks/Impacts:

- potential sensitive environment affected may include emergent riverine wetlands, and backwater habitat and pools*
- elevated ammonia levels exceeding Indiana water quality criteria have been detected in the river; however, no adverse effects are mentioned
- no observed impact on flora and fauna

Documents Reviewed:

- Summary of Remedial Investigation/Feasibility Study (from draft FY 87 CERCLA Report to Congress).
- Record of Decision; September 30, 1987.
- Remedial Investigation Report; June 1987.
- Feasibility Study Report; June 1987.

OUTBOARD MARINE
WAUKEGAN, IL
REGION 5

Type of Site: contaminated harbor

Major Release Pathways:

- discharge of process cooling water and floor drains at Outboard Marine; drains closed in 1971
- release of contaminated soil via surface water runoff into tributary, and subsequent discharge into lake
- seepage into ground water, which discharges to surface water; it is estimated that contaminated ground water from Outboard Marine site will begin releasing about 8 lb/year of PCBs into Lake Michigan in approximately 60 years

Principal Contaminants: PCBs

Media/Biota Observed to be Contaminated:

- fish
- shellfish
- benthic organisms
- soil
- sediments
- surface water
- surface film

Main Ecological Risks/Impacts:

- 37 acres in harbor plus 10 kilometers outside harbor contaminated with PCBs
- 22 pounds/year of PCBs are released to Lake Michigan from Waukegan Harbor
- contamination of fish (and bioaccumulation) through ingestion of contaminated aquatic organisms, insects and plants, and uptake of contaminated water
- contamination of shellfish and benthic organisms
- decreased diversity and equitability of benthic macroinvertebrates due to sediment contamination
- relative scarcity of fish in harbor area
- potential reduction in elasticity of ecosystem, including increased vulnerability to new sources of stress

- potential inhibition of phytoplankton photosynthesis and related potential reduction in growth of fish that require phytoplankton for food
- potential fish fry mortality
- potential reduction in natural fish populations due to interference of high concentrations of PCBs in sediments with development of eggs deposited on bottom
- potential for reduced reproduction of waterfowl and viability of young
- potential alterations in behavior at species level
- potential decrease in immuno-suppression in birds and animals
- increased toxicity to higher trophic level organisms
- Fifteen species of birds and five species of plants classified as endangered by State of Illinois are known or are likely to be present in the site area; bald eagle has been observed in the harbor area during migration periods

Documents Reviewed:

- Outboard Marine Feasibility Study: Assessment of Potential Impacts; no date.
- ICF Chart on Ecological Threats at Outboard Marine Corporation Site; March 1988.
- Summary Data for HRS Scoring at Outboard Marine Corporation; June 4, 1987.

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SCHMALTZ DUMP SITE
CALUMET COUNTY, WI
REGION 5

Type of Site: inactive landfill

Major Release Pathways:

- direct release of PCBs from demolition debris scattered over site
- soil runoff to onsite ponded water
- potential discharge of ground water to surface water

Principal Contaminants:

- inorganics: Pb, Cr
- organics: N/A

Media/Biota Observed to be Contaminated:

- soil
- onsite ponded water
- ground water

Main Ecological Risks/Impacts:

- 7 acres of soil contaminated with PCBs, lead, and chromium
- potential contamination of and toxicity to aquatic life of Lake Winnebago if discharge of contaminated ground water occurs
- site occupies approximately seven acres of wetland area
- potential contamination of and toxic effects to birds and other terrestrial wildlife or amphibians that may ingest contaminated soil-dwelling organisms*
- potential contamination of offsite surface water and sediments

Documents Reviewed:

- Preliminary Risk Assessment; April 12, 1985.
- Draft Public Health Evaluation; September 8, 1986.
- Record of Decision; 1987.

SEYMOUR RECYCLING CORPORATION
SEYMOUR, IN
REGION 5

Type of Site: inactive facility that processed, stored, and incinerated chemical wastes

Major Release Pathways:

- fugitive dust
- volatilization from soil
- surface water runoff
- ground-water discharge to surface water and offsite soils

Principal Contaminants:

- inorganics: N/A
- organics: 1,2-dichloroethane; benzene; vinyl chloride; 1,1.1-trichloroethane

Media/Biota Observed to be Contaminated:

- sediment
- ground water
- soil
- fish
- terrestrial biota

Main Ecological Risks/Impacts:

- fish kills reported
- potential effects to other aquatic biota in onsite ditch and off-site creeks*
- no sensitive environments identified or potentially affected

Documents Reviewed:

- Summary of Remeidal Investigation/Feasibility Study (from draft FY 87 CERCLA Report to Congress).
- Record of Decision; September 4, 1987.
- Remedial Investigation; May 12, 1986.
- Public Comment Feasibility Study Report; August 29, 1986.

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VELSICOL SITE
MARSHALL, IL
REGION 5

Type of Site: active pesticide (chlordane) manufacturing facility

Major Release Pathways:

- accidental spills
- seepage into ground water, which then discharges to surface water
- surface runoff
- direct discharge to surface water

Principal Contaminants:

- inorganics: Cd, Pb, Zn, ammonia, chloride, sulfate
- organics: chlordane, 2-methylnaphthalene, acenapthene, PAHs (fluorene, naphthalene, phenanthrene, pyrene), hexachlorocyclopentadiene, di-n-butylphthalate, beta-benzene hexachloride

- others: alkalinity, TDS

Media/Biota Observed to be Contaminated:

- surface soil
- surface water (stream)
- surface water sediment
- ground water
- fish

Main Ecological Risks/Impacts:

- potential for chronic toxic effects mainly to aquatic organisms, and a lesser extent to terrestrial organisms
- stream sediments may be contaminated for over 2 miles downstream*
- potential for bioaccumulation and subsequent increased toxic effects

Document Reviewed: Remedial Investigation Report; February 19, 1988.

EPA REGION 6 SITES

MID-SOUTH WOOD PRODUCTS
MENA, AR
REGION 6

Type of Site: wood treating facility

Major Release Pathways: waste ponds overflow and surface water runoff, ground-water migration, subsurface soil leachate, and soil erosion

Principal Contaminants:

- inorganics: As, Cr
- organics: pentachlorophenol and other creosote compounds

Media/Biota Observed to be Contaminated:

- onsite soil, sediment, surface water, ground water
- offsite surface water
- vegetation
- fish

Main Ecological Risks/Impacts:

- pentachlorophenol (a potent herbicide) prevents vegetative growth onsite
- fish kill in 1976 extended 17.5 miles downstream, with the severity of the kill ranging from 10 to 100 percent
- potential chronic effects and other acute effects to the aquatic riverine system*

Documents Reviewed:

- Site Background Information; April 1986.
- Remedial Investigation Report: Regulatory History; October 24, 1984.
- ICF Chart on Ecological Threats at Mid-South Wood Products Site; March 1988.

UNITED NUCLEAR CORPORATION
CHURCH ROCK, NM
REGION 6

Type of Site: inactive uranium mill and mill tailings pile

Major Release Pathways:

- accidental spill (breach of tailings pond released 93 million gallons of tailings solution)
- direct discharge to stream/river system
- wind erosion

Principal Contaminants:

- inorganics: As, Cd, Cr, Cu, Pb, Ni, radionuclides (Th, Ra), nitrate, sulfate
- others: TDS, low pH

Media/Biota Observed to be Contaminated:

- stream and river banks and bottom sediments
- ground water
- soil
- air
- livestock (no other biota examined)

Main Ecological Risks/Impacts:

- contamination of livestock grazing in area (potential for similar contamination of terrestrial wildlife*)
- potential chronic toxic effects to aquatic and terrestrial organisms (organisms potentially exposed the most are benthic organisms or organisms residing in river bank area)
- although not addressed in documents available, there probably were acute toxic effects to aquatic and terrestrial organisms caused by one-time major spill*
- stream sediments and banks contaminated for at least 1.5-2 miles downstream
- no threatened/endangered plants or animals observed in area, although two plants proposed for endangered status suspected in area and the area is known to include the geographical range of three terrestrial animals that have endangered status

Documents Reviewed:

- Final Remedial Investigation/Feasibility Study; March 7, 1984.
- Endangerment Assessment; June 1985.
- Biological Assessment After Uranium Mill Tailings Spill; December 24, 1980.
- Technical memorandum summarizing the Phase I Field Study; October 4, 1985.
- Ground Water Discharge Plan for UNC; no date.
- Documentation Records for HRS; no date.
- Sampling Inspection at United Nuclear Corporation; May 4, 1983.
- Water quality Data for Discharges from Uranium Mines and Mills in New Mexico; no date.

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WICHITA MOUNTAIN WILDLIFE REFUGE
COMANCHE COUNTY, OK
REGION 6

Type of Site: 3 isolated, primitive ore-grinding structures, also known as arrastras, in which Hg was added to form an amalgamate with gold and silver during the late 1800s

Major Release Pathways: direct contact with potential Hg leachate from arrastras; mobilization of Hg leachate to surrounding terrestrial and aquatic media

Principal Contaminants: Hg

Media/Biota Observed to be Contaminated: soil

Main Ecological Risks/Impacts: no media or biota contaminant levels were compared to ecological protection criteria; levels in soil samples and fish tissue samples were compared only with human health criteria

Documents Reviewed:

- Summary of the Lake Lawtonka Sampling Study; March 27, 1987.
- An Evaluation of Mercury Contamination at the Wichita Mountains Wildlife Refuge; September 1986.
- Study of Lake Lawtonka; May 21, 1984.

EPA REGION 9 SITES

IRON MOUNTAIN MINE
REDDING, CA
REGION 9

Type of Site: abandoned mine (mined for silver, gold, copper, zinc, and pyrite)

Major Release Pathways: acid mine drainage (of ground water) from mine workings

Principal Contaminants:

- inorganics: Cd, Cu, Zn
- organics: N/A

Media/Biota Observed to be Contaminated:

- ground water
- surface water
- fish
- surface water sediments

Main Ecological Risks/Impacts:

- surface water exceeds acute and chronic AWQC for zinc
- an average of 423 pounds of copper, 1,466 pounds of zinc, and 10.4 pounds of cadmium are released from the mine area into surface water each day
- surface water and sediments downstream of the mine appear to be contaminated for approximately 7 miles (estimate from map)*
- population of king salmon, steelhead, wild trout, and other aquatic life in the Sacramento River have experienced numerous instances of mortality since the 1940's (the last occurrence was in 1969 when 200,000 salmon were killed); there are also frequent occurrences of sublethal heavy metal concentrations in the river that exceed safe levels for trout and salmon
- portions of creeks downstream of mine are essentially devoid of life
- king salmon runs in the upper Sacramento River have declined by 87% in the last 20 years; and winter runs of Chinook salmon have declined 50%
- reduced rates of growth of aquatic species, interference with

physiological processes necessary for successful migration, and inhibition of gill function have been observed
- bioaccumulation of copper and cadmium in fish
- contaminated spawning grounds for Chinook salmon in Sacramento River
- potential contamination of and toxic effects to terrestrial wildlife that ingest contaminated surface water or fish*

Documents Reviewed: Remedial Investigation Report; August 1985.

EPA REGION 10 SITES

QUEEN CITY FARMS
MAPLE VALLEY, WA
REGION 10

Type of Site: inactive disposal ponds

Major Release Pathways:

- overflow from ponds into lake and low lands during storm events
- seepage from ponds into ground water, which may discharge to surface at distance locations

Principal Contaminants:

- inorganics: Cd, Cr, Cu, Pb, Zn
- organics: vinyl chloride, PCBs, benzo(a)pyrene, pentachlorophenol, trichloroethene, 1,2-transdichloroethene, cyanide

Media/Biota Observed to be Contaminated:

- soil (surface and subsurface)
- surface water (lake)
- surface water sediment
- ground water
- vegetation

Main Ecological Risks/Impacts:

- vegetation killed in isolated areas, although possibly due to contaminated runoff from landfill on adjacent property
- potential contamination of and chronic toxic effects to aquatic and terrestrial organisms, including bioaccumulation of PCBs (vegetation in margins of lake, migrating birds and waterfowl, and terrestrial wildlife potential receptors); maximum concentrations of cadmium, chromium, copper, lead, zinc, and PCB in downgradient seep of ground water exceed chronic AWQC by 1-5 orders of magnitude
- potential acute effects to terrestrial wildlife that ingest contaminated water in onsite disposal ponds (concentrations of cadmium, chromium, copper, lead, zinc, and pentachlorophenol in ponds exceed acute AWQC by 1-5 orders of magnitude)
- potential contamination and degradation of habitat in wetlands associated with lake*

Documents Reviewed:

- HRS Panel Summary Risk Assessment for Queen City Farms; June 1987.
- ICF Chart on Ecological Threats at Queen City Farms Site; March 1988.
- Focused Remedial Investigation; February 7, 1985.
- Final Endangerment Assessment Report; November 1985.
- Field Investigations of Uncontrolled Hazardous Waste Sites; March 1981.
- Assessment of Hydrogeology and Ground Water Quality; December 13, 1983.

APPENDIX C

DETAILED SUMMARY OF ECOLOGICAL THREAT DATA FOR SUPERFUND SITES

EXHIBIT C-1
NATURE OF OBSERVED CONTAMINATION OR OBSERVED BIOLOGICAL/ECOLOGICAL EFFECTS[a]

Type of Ecosystem Affected[b]	Media Contaminated	Principal Contaminants	Biota Contaminated	Observed Biological/Ecological Effect
Freshwater River/ Stream/Wetland/ Lake (44)	Ground Water (38) Soil (35) Sediments (34) Surface Water (33) Air (5)	Pb (22) VOCs (22)[c] As (18) Cd (17) Cr (17) Zn (15) Ni (13) Cu (11) PCBs (9) PAHs (9)[e] Hg (7) Phthalates (7) Mn (6) Cyanide (5) Ba (5) Phenols (5) Other Inorg. (28)[d] Other Org. (17)[d]	Fish (25) Vegetation (15) Aquatic Invertebrates (7) Mammals (2) Reptiles (2) Birds (1)	Toxicity to Aquatic Fauna (11) (Except Fish Kill) Toxicity to Vegetation (11) Bioaccumulation (7) Altered Species Diversity (6) Fish Kill (4) Toxicity to Terrestrial Fauna (1)
Terrestrial (12)	Soil (12) Surface Water (11) Ground Water (10) Sediments (9) Air (2)	Pb (7) VOCs (6) Cr (6) As (5) Cd (5) Zn (5) Other Inorg. (16)[d] Other Org. (12)[d] Asbestos (1) TDS (1)[f]	Vegetation (9) Fish (6)[g] Mammals (2) Amphibians (1)	Toxicity to Vegetation (9) Bioaccumulation (2) Toxicity to Aquatic Fauna (2)[g] (Except Fish Kill) Fish Kill (1)[g]
Estuary (6)	Sediments (6) Surface Water (5) Ground Water (4) Soil (3) Air (1)	Cd (3) Pb (3) PCBs (3) Ni (2) Cu (2) VOCs (2) Other Inorg. (7)[h] Other Org. (3)[h] Asbestos (1) TDS (1)	Fish (5) Aquatic Invertebrates (4) Vegetation (3) Mammals (1) Reptiles (1)	Toxicity to Aquatic Fauna (2) (Except Fish Kill) Altered Species Diversity (1) Bioaccumulation (1) Toxicity to Terrestrial Fauna (1)
Bay/Harbor (2)	Surface Water (2) Sediments (1) Soil (1) Ground Water (1)	Pb (2) Cd (1) Cu (1) NH_3 (1) PCBs (1) VOCs (1) Pesticides (1)	Fish (2) Aquatic Invertebrates (2)	Toxicity to Aquatic Fauna (2)

EXHIBIT C-1
NATURE OF OBSERVED CONTAMINATION OR OBSERVED BIOLOGICAL/ECOLOGICAL EFFECTS

FOOTNOTES

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a/ The numbers in parentheses represent the approximate number of sites, out of 52, at which the particular ecosystem has been affected, or at which the particular medium contamination, biota contamination, or biological/ecological effect has been observed. Because of uncertainties in classifying each site into the categories used in this table, these numbers are only approximate and indicative of the relative frequency of occurrence of types of observed contamination and effect.

b/ Because a given site may have been observed to affect more than one type of ecosystem, and because a given site's effect on an ecosystem may not have been observed, the numbers in this column do not sum to 52. For the same reasons, the numbers for a given type of contamination or effect (e.g., media contaminated) do not sum to 52, and the numbers for a specific type of contamination or effect that pertain to a given "type of ecosystem affected" (e.g., terrestrial) do not sum to the total number of sites for that "type of ecosystem affected."

c/ Volatile organic compounds. This category includes a variety of both aromatic hydrocarbons (e.g., benzene, toluene) and chlorinated hydrocarbons (e.g., trichloroethylene (TCE), perchloroethylene (PCE)).

d/ This category includes various contaminants that were observed as "principal contaminants" at less than five sites.

e/ Polynuclear aromatic hydrocarbons (e.g., benzo(a)pyrene, naphthalene).

f/ Total dissolved solids.

g/ Although these categories do not directly concern terrestrial ecosystems, they are included here because they were noted at some of the 11 sites that affected terrestrial ecosystems, and because aquatic fauna may be consumed by (and therefore contaminate) terrestrial fauna.

h/ This category includes various contaminants that were observed as "principal contaminants" at only one site.

EXHIBIT C-2

NATURE OF PROJECTED BIOLOGICAL/ECOLOGICAL EFFECTS FROM OBSERVED MEDIA CONTAMINATION[a]

Type of Ecosystem Potentially Affected[b]	Media Contaminated	Principal Contaminants	Projected Biota Contaminated	Projected Biologial/Ecologial Effects[c]
Freshwater River/ Stream/Wetland/ Lake (33)	Ground Water (30) Soil (28) Surface Water (27) Sediments (27) Air (4)	Pb (16) VOCs (16) Cr (16) As (15) Cd (13) Zn (12) PCBs (10) PAHs (9) Cu (8) Mn (7) Fe (7) Hg (5) Other Inor. (19)	Birds (19) Mammals (19) Aquatic Invertebrates (16) Fish (9) Amphibians (8) Vegetation (8) Reptiles (6)	Bioaccumulation (18) Toxicity to Aquatic Fauna (17) Toxicity to Terrestrial Fauna (17) Toxicity to Vegetation (4) Altered Species Diversity (3)
Terrestrial (20)	Ground Water (16) Soil (16) Sediments (14) Surface Water (13) Air (1)	Pb (11) VOCs (9) Zn (8) Cd (7) PCBs (7) PAHs (7) As (6) Cr (6) Cu (5) Other Inorg. (17) Other Org. (5)	Mammals (15) Birds (13) Aquatic Invertebrates (5)[d] Amphibians (5) Fish (3)[d] Vegetation (2) Reptiles (2)	Toxicity to Terrestrial Fauna (15) Toxicity to Aquatic Fauna (10)[d] Bioaccumulation (6) Altered Species Diversity (3) Toxicity to Vegetation (1)
Estuary (6)	Soil (4) Surface Water (4) Sediments (4) Ground Water (3)	Pb (4) VOCs (3) Cd (3) As (2) Cr (2) Ni (2) PCBs (2) Cu (1) PAHs (1) Phthalates (1) Pesticides (1)	Fish (2) Aquatic Invertebrates (2) Birds (2) Vegetation (1) Mammals (1)	Bioaccumulation (2) Toxicity to Aquatic Fauna (1) Toxicity to Terrestrial Fauna (1) Toxicity to Vegetation (1) Altered Species Diversity (1)
Bay/Harbor (2)	Surface Water (2) Sediments (2) Soil (2) Ground Water (1)	Pb (1) Cr (1) Cu (1) PCBs (1) VOCs (1) PAHs (1)	Vegetation (1) Fish (1) Aquatic Invertebrates (1) Mammals (1) Birds (1) Reptiles (1) Amphibians (1)	Bioaccumulation (3) Altered Species Diversity (1) Toxicity to Vegetation (1) Toxicity to Aquatic Fauna (1) Toxicity to Terrestrial Fauna (1)

EXHIBIT C-2
NATURE OF PROJECTED BIOLOGICAL/ECOLOGICAL EFFECTS FROM OBSERVED MEDIA CONTAMINATION

FOOTNOTES

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a/ The numbers in parentheses represent the approximate number of sites, out of 52, included in each category. Specifically, the numbers indicate how many sites:

-- are projected to have the specified ecosystem affected;

-- have observed contamination of the indicated environmental media;

-- are contaminated with each of the principal contaminants;

-- are projected to have contamination of the specified biota based on observed contamination; and

-- are projected to have the indicated biological/ecological effects.

Because of uncertainties in classifying each site into the categories used in this table, these numbers are only approximate and indicative of the relative frequency of occurrence of types of media contamination and projected biological/ecological effect.

b/ Because a given site may have potentially affected more than one type of ecosystem, and because a given site may not have potentially affected any ecosystem at all, the numbers in this column do not sum to 52. For the same reasons, the numbers for a given type of potential contamination or effect (e.g., media contaminated) do not sum to 52, and the numbers for a specific type of potential contamination or effect that pertain to a given "type of ecosystem affected" (e.g., terrestrial) do not sum to the total number of sites for that "type of ecosystem affected."

c/ This column includes the potential effects noted in site documentation as well as potential effects not discussed in the documentation but judged to be significant by site documentation reviewers. The specific potential effects noted only by site documentation reviewers are indicated by asterisks in Appendix B (Summary of Ecological Threat Data for Individual Sites).

d/ Although these categories do not directly concern terrestrial ecosystems, they are included here because they were noted at some of the 14 sites with potentially affected terrestrial ecosystems, and because aquatic fauna may be consumed by (and therefore potentially affect) terrestrial fauna.

EXHIBIT C-3
THREATS TO SENSITIVE/SPECIAL ENVIRONMENTS

Sensitive/Special Environment Category	Number of Sites with Sensitive Environment Contaminated[a]	Number of Sites Projected to have Sensitive Environment Contaminated[a]	Nature of Contamination/Effect[b]	
			Observed	Projected
Wetlands/Marsh/Swamp	18	12	■ Contaminated surface water (14) ■ Contaminated sediments (16) ■ Contaminated soil (16) ■ Contamination of and/or damage to and death of vegetation (9) ■ Contamination of benthic organisms (3) ■ Contamination of fish (11) ■ Contamination of other aquatic organisms (other than fish and benthic organisms) (4) ■ Contamination of mammals (1) ■ Fish kill (2) ■ Physical deformities and growths in fish (2)	■ Contamination of surface water (16) ■ Contamination of sediments (14) ■ Uptake of contaminants by vegetation (5) ■ Contamination of soil (9) ■ Contamination or bioaccumulation of contaminants in aquatic organisms (11) ■ Contamination of benthic organisms (4) ■ Contamination of terrestrial wildlife (e.g., birds, small mammals) (15) ■ Reduced reproductive success in birds (3) ■ Reduced reproductive success in fish (2) ■ Reduced growth of aquatic organisms (2) ■ Contamination of soil-dwelling invertebrates (1)

EXHIBIT C-3
THREATS TO SENSITIVE/SPECIAL ENVIRONMENTS (cont'd)

Sensitive/Special Environment Category	Number of Sites with Sensitive Environment Contaminated[a]	Number of Sites Projected to have Sensitive Environment Contaminated[a]	Nature of Contamination/Effect[b]	
			Observed	Projected
Endangered Species Habitat/Migration Pathway	3	10	■ Decline in numbers of winter run Chinook Salmon of 50% in 20 years (Move is currently underway to place them on State's endangered species list.) (1) ■ Contamination and limited numbers of Lake Whitefish -- State endangered species (1) ■ Ecosystem damage to endangered species habitat (American Alligator) and proposed endangered species (Alabama Red-Bellied Turtle) (1)	■ Contamination of bald eagles (5) ■ Contamination of other endangered bird species (5) ■ Contamination of State-designated endangered plant species (2) ■ Contamination of aquatic endangered species (1) ■ Contamination of terrestrial endangered species other than birds (1)
Wildlife Refuge	2	3	■ Contaminated soil (2) ■ Contaminated surface water (1) ■ Contaminated sediments (1) ■ Contaminated vegetation (1)	■ Contamination of surface water, sediments, vegetation, and birds at wildlife refuge from sites nearby (3)

EXHIBIT C-3
THREATS TO SENSITIVE/SPECIAL ENVIRONMENTS (cont'd)

Sensitive/Special Environment Category	Number of Sites with Sensitive Environment Contaminated[a]	Number of Sites Projected to have Sensitive Environment Contaminated[a]	Nature of Contamination/Effect[b]	
			Observed	Projected
Sensitive Spawning/ Breeding Areas	3	1	■ Contaminated surface water and sediments in sensitive spawning area (2) ■ Contaminated surface water, soil, vegetation and aquatic organisms in nesting and breeding area of endangered bird species (1)	■ Contamination of surface water in area of wildlife refuge designed for propagation of fish and waterfowl (1)
Estuary	2	3	■ Contaminated surface water (2) ■ Contaminated surface water sediments (2) ■ Contaminated soil (1) ■ Contamination of vegetation (1) ■ Bioaccumulation of PCBs in fish (1) ■ Contamination of benthic community (1) ■ Reduced reproductive success, species diversity in aquatic organisms (1)	■ Contaminated sediments (2) ■ Contaminated soil (2) ■ Contaminated surface water (2) ■ Contaminated vegetation (1) ■ Decreased populations of aquatic biota due to PCB contamination of surface water and sediments (2) ■ Contamination of terrestrial biota (1) ■ Reduced growth of aquatic organisms (1)

EXHIBIT C-3
THREATS TO SENSITIVE/SPECIAL ENVIRONMENTS (cont'd)

Sensitive/Special Environment Category	Number of Sites with Sensitive Environment Contaminated[a]	Number of Sites Projected to have Sensitive Environment Contaminated[a]	Nature of Contamination/Effect[b]	
			Observed	Projected
Other (State parks, lakes adjacent to parks, Indian reservation, nature study areas)	3	1	▪ Contaminated surface water (1) ▪ Contaminated soil (2) ▪ Contaminated surface water sediments (2) ▪ Low aquatic species diversity and quantity (1) ▪ Bioaccumulation of organics in fish (2) ▪ Contaminated stream and riverbank (1) ▪ Toxicity and mortality of aquatic organisms (2) ▪ Contaminated vegetation (2)	▪ Contamination of surface water (1) ▪ Contamination of sediments (1) ▪ Contamination of terrestrial wildlife (2) ▪ Contamination of benthic organisms (1) ▪ Acute toxic effects to aquatic organisms (2) ▪ Acute toxic effects to terrestrial organisms (1)

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[a] Each site is included in only one of these columns. Therefore, the numbers of sites with sensitive environment contaminated and the numbers of sites with sensitive environment potentially contaminated are additive.

[b] The numbers in parentheses represent the number of sites that have the noted observed or potential ecological effects. Both observed and potential ecological effects may result from sites known to have a sensitive environment contaminated. Therefore, effects from one site may appear in one or both of these columns. The numbers in these columns are not additive and, because of judgments and uncertainties associated with placing each site into the above categories, the numbers should be considered only approximate.

EXHIBIT C-4
EXTENT OF ECOLOGICAL IMPACTS[a/]

Category of Environmental Impact and Site Name	Areal Extent of Contamination	Magnitude of Contamination[b/]
SURFACE WATER CONTAMINATION		
Chisman Creek	36 acres of freshwater ponds (4) contaminated with arsenic, cadmium, copper, lead, nickel, selenium, vanadium, and zinc	Exceeds AWQC for lead, vanadium
Site name confidential[c/]	1.1 miles of surface water in brook contaminated with lead, nickel, and zinc	Lead and nickel exceed chronic AWQC by 45x and 6x respectively
Hudson River PCBs	200 mile stretch of river contaminated with PCBs	PCBs exceed acute and chronic AWQC up to 14.3x
Iron Mountain Mine	Up to 7 miles of surface water contaminated with cadmium, copper, zinc	Surface water exceeds chronic AWQC for zinc up to 6x
Lipari Landfill	26 acres of lake contaminated with bis(2-lead chloroethyl)ether (BCEE), mercury, and lead	Exceeds human health criteria for consumption of fish for BCEE and mercury, and chronic AWQC for lead 5x
	1,500 feet of streams contaminated with bis(2-chloroethyl)ether, toluene, arsenic, chromium, mercury, and lead	Exceeds human health criteria for consumption of fish for BCEE, exceeds acute AWQC for lead by 1.5x and is equivalent to chronic AWQC for chromium
Munisport Landfill	Inorganic contaminants in river approximately 2,000 feet from site	Exceeds acute AWQC for copper 10x and Dade County criterion for lead 4x.
	Approximately 8 on-site lakes contaminated, the largest two of which are 8.0 and 4.6 acres, respectively	Exceeds chronic AWQC for copper 2x and State of Florida criterion for zinc 5x.
Site name confidential	6 square miles of estuary contaminated with PCBs, copper, cadmium, and lead	Exceeds acute and/or chronic AWQC for PCBs up to 264x, for copper up to 41x
Outboard Marine	37 acres in harbor plus 10 kilometers outside harbor contaminated with PCBs	PCBs exceed acute AWQC up to 43x
Queen City Farms	2-3 acres of ponds (6) contaminated with various organics and cadmium, chromium, copper, lead, zinc, and cyanide	Exceeds acute AWQC for cadmium by up to 6,920x, chromium by up to 414,000x, copper by up to 89,200x, lead by up to 1,840x, zinc by up to 375x, and pentacholorophenol by up to 273x

EXHIBIT C-4
EXTENT OF ECOLOGICAL IMPACTS[a] (continued)

Category of Environmental Impact and Site Name	Areal Extent of Contamination	Magnitude of Contamination[b]
CONTAMINATION OF SURFACE WATER SEDIMENTS		
Hudson River PCBs	200 miles of river sediments contaminated with PCBs	Approximately 229 metric tons estimated to remain in upper Hudson River area; concentrations of PCBs range up to 250 ppm; 40 PCB "hot spot" areas
Iron Mountain Mine	7 miles of stream/river sediments contaminated with cadmium, copper, zinc	An average of 423 pounds of copper, 1,466 pounds of zinc, and 10.4 pounds of cadmium are released from the mine area each day
Lipari Landfill	1,500 feet of stream sediments contaminated with bis(2-chloroethyl)ether, chromium, lead, zinc, and mercury	Concentrations of lead and chromium exceed background levels by 820x and 15x, respectively
	26 acres of sediments in lake contaminated with arsenic, mercury, lead, and zinc	Arsenic and mercury concentrations exceed background levels in lake
Marathon Battery	34 acres of cove sediments contaminated with metals	Contains metal contamination above cleanup levels
Site name confidential	6 square miles of estuary contaminated with PCBs, cadmium, copper, and lead	Maximum concentrations exceed no-observed-effects levels 260x for PCBs, 19x for cadmium, 6x for copper, 6x for lead
Outboard Marine	37 acres in harbor plus 10 kilometers outside harbor sediments contaminated with PCBs	22 pounds/year of PCBs are released to Lake Michigan from Waukegan Harbor
Re-Solve	300 feet of unnamed tributary contaminated with PCBs	Sediments are "highly contaminated" with PCBs to a depth of 1 foot
Site name confidential	1,200 feet of stream sediments contaminated with asbestos	Sediments contain up to 30% asbestos
United Nuclear Corporation	1.5-2.0 miles of stream sediments and river bank contaminated with radionuclides and metals	Released 93 million gallons of tailings solution in accidental spill; radionuclide concentrations now in sediment between 5 and 50x health-based cleanup levels for surface soil

EXHIBIT C-4
EXTENT OF ECOLOGICAL IMPACTS[a] (continued)

Category of Environmental Impact and Site Name	Areal Extent of Contamination	Magnitude of Contamination[b]
CONTAMINATION OF SOIL		
Army Creek Landfill	44 acres of soil contaminated with metals and organics	Soil not sampled; landfill contains refuse ranging from 6-35 feet in depth over 44-acre area
Chemical Control	2.2 acres of soil contaminated with organics and metals	18,000 cubic yards of soil contaminated
L.A. Clarke	Area of approximately 10 acres contaminated with polynuclear aromatic hydrocarbons	163,000 cubic yards of soil contaminated
Clothier	6 acres of soil contaminated with organics and metals	PCB concentrations up to 92 ppm, phenols up to 34.2 ppm, barium up to 50 ppm, and arsenic up to 4.4 ppm
Site name confidential	15 acres of soil contaminated with organics and metals	N/A[d]
Delaware Sand and Gravel	12.5 acres of soil contaminated with metals	Approximately 535,000 cubic yards of contaminated soil
Fort Wayne Reduction	35 acres of soil contaminated with organics and metals	VOCs detected up to thousands of ppm
Geiger	2.6 acres of soil contaminated with PCBs and metals	Lead and chromium concentrations in soil exceed concentrations known to be phytotoxic
Lipari Landfill	700' x 200' area of marsh soil (3.2 acres) contaminated with organics and metals	Contamination with several organic compounds up to 3 orders of magnitude over background, and metals up to 6 orders of magnitude over background
Mid-South Wood Products	Approximately 5 acres of soil contaminated with pentachlorophenol, chromium, free oil	N/A
F. O'Connor	5 acres of soil contaminated with PCBs and metals	PCB concentrations up to 6,205 ppm, lead up to 47x background, and cadmium up to 160x background
Palmerton Zinc	2,000 acres of soil contaminated with metals	Cadmium, lead, and zinc concentrations exceed background levels by 2,600x, 2,000x and 400x respectively
Queen City Farms	N/A	17,000 cubic yards of soil contaminated with organics and metals

EXHIBIT C-4
EXTENT OF ECOLOGICAL IMPACTS[a/] (continued)

Category of Environmental Impact and Site Name	Areal Extent of Contamination	Magnitude of Contamination[b/]
Schmaltz Dump	7 acres of soil contaminated with PCBs, lead, chromium	PCB concentrations up to 10 mg/kg, lead up to 1,940 mg/kg, and chromium up to 964 mg/kg
Site name confidential	20 acres of soil covered with asbestos-laden tailings and ore	Tailings and ore contain between 5% and 40% asbestos
West Virginia Ordnance Works	Up to a 60 acres of soil contaminated with nitroaromatics, lead, PAHs	Nitroaromatic concentrations greater than 1,000 ug/g over roughly 1 acre, and greater than 100 ug/g over another 2-3 acres. Maximum lead concentration is 1,400 ug/g and maximum PAH concentration is 100 ug/g
FISH KILLS		
Iron Mountain Mine	Several fish kills have occurred extending up to 7 miles downstream	Last fish kill occurred in 1969; 200,000 salmon were killed
Mid-South Wood Products	Fish kill in 1976 extended 17.5 miles downstream	Severity of fish kill ranged from 100%-10%
Mowbray Engineering	Fish kill in 1980 extended 2.5 miles downstream	2.5-mile length of stream virtually devoid of life after 1980 incident
Seymour Recycling	Fish kill in creeks next to property extended 1,100 feet downstream	N/A
DEFOLIATION		
L.A. Clarke	Several areas of stressed vegetation totaling less than one acre	N/A
Mid-South Wood Products	5.5 acres of area devoid of vegetation due to pentachlorophenol	N/A
Palmerton Zinc	2,000 acres on Blue Mountain completely defoliated due to emissions containing cadmium, lead, and zinc	N/A
Site name confidential	Vegetation will not grow on area of at least 5 acres	N/A
West Virginia Ordnance	Death of vegetation on approximately 1 acre, vegetation growth inhibited on approximately 2-3 additional acres	N/A

EXHIBIT C-4
EXTENT OF ECOLOGICAL IMPACTS[a] (continued)

Category of Environmental Impact and Site Name	Areal Extent of Contamination	Magnitude of Contamination[b]
CONTAMINATION/DEGRADATION OF WETLANDS/MARSHES		
Lipari Landfill	Contamination of an 8 acre marsh with organics, mercury, lead	Large, dead trees in marsh potentially stressed from exposure to leachate and contaminated soil
Marathon Battery	284 acres of marsh sediments contaminated with metals (up to 2 miles from plant)	5-10 metric tons of cadmium remain in marsh; widespread cadmium and nickel contamination, comprising 1-17% of sediments on a dry weight basis
Mowbray Engineering	Contamination of 3 acres of swamp with oils and PCBs	Bullrushes in swamp contain PCBs at 8.9 mg/kg (this concentration is above background concentrations)
Re-Solve	Contamination of 0.1 acres of wetlands with PCBs	Contamination in sediments of more than 1 ppm of PCBs to a depth of roughly 1.5 feet
Wildcat Landfill	Degradation and loss of 29 acres of wetlands habitat	N/A

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a/ Explicit information was provided on areal extent of contamination for 28 of the 52 sites in the sample (for at least one environmental medium); only those 28 sites are included in this exhibit.

b/ Indicates degree to which contaminant levels exceed applicable criteria such as AWQC. This information is not provided for soil and sediment contaminants because generally applicable criteria for these media do not exist.

c/ Name of site withheld because information reviewed is in draft form.

d/ Additional information not available in site documentation reviewed.

APPENDIX D

REGIONAL AND STATE RCRA CONTACTS AND INTERVIEW SUMMARIES

RCRA Ecorisk Regional and State Contacts

Region	Contact		State Contact
I	George Furst[1] (617) 573-574		
	Matt Hoaglund (617) 573-5775	ME	Stacy Ladner (207) 289-2651
	Larry Brill (617) 565-3560		Jim Glasgow (207) 289-2651
	Dave Lim (617) 573-5766		Scott Whittier (207) 289-2651
			Andy Cobb (207) 289-2651
	John Zipeto (617) 573-5744	MA	Jeff Chorman (617) 292-5888
			Ralph Fine (617) 292-5888
II	Ellen Doring (212) 264-1362	NY	Steve Cominsky (518) 457-9696
	Barry Tornick (212) 264-4479	NJ	Ernie Kuhlwein, Section Chief (609) 292-9880
			Bill Sharples, Engineer (609) 292-9880
III	Jack Potosanak (215) 597-8338		
	Diane Schott (215) 597-8256	DE	Wayne Thomas (302) 736-3824
	Jim Webb		

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[1] Names in bold indicate persons interviewed. Non-bold names are recommended contacts.

RCRA Ecorisk Regional and State Contacts (Continued)

Region	Contact		State Contact
IV	Mickey Hartnett (404) 347-3433	GA	Mark Smith, Proj. Officer (404) 656-7802
		FL	Satish Kastury, Hz. Waste Div. (904) 488-0130
		AL	Buddy Cox, Hz. Waste Div. Chief (205) 271-7730
		KY	Muhammad Alauddin, Hz. Waste Branch Manager (502) 564-6716
		MS	Sam Maberry, Hz. Waste Div. Chief (601) 961-5101
		NC	Bill Meyer Bill Hanner (919) 733-2178
		SC	Hartsill Truesdale, Solid/Hz. Waste Div. Chief (803) 734-5200
		TN	Dwight Hinch (615) 741-3424
V	Joe Boyle (312) 886-4449	IL	Bill Rodlinski, State RCRA program development (217) 782-9898
			Glenn Savage, Section Manager RCRA field operations (217) 785-7402
			Janis Perino, Director, Ecotox. program (217) 782-8700
	Jim Brossman (312) 886-4447	OH	Mike Savage, Enforcement (614) 644-2947
			Ed Kitchen, Permitting (614) 644-2963
		MN	Larry Christianson, Perm. & Enforc. (612) 296-7784

RCRA Ecorisk Regional and State Contacts (Continued)

Region	Contact		State Contact
		IN	John Hayworth (317) 232-8857
VI	Maria Daniels	TX	Minor Hibbs, Chief of Permits (512) 463-8173
	Doug Ablen (214) 655-6719	OK	Robert Rabitane, Environmental Programs (405) 271-5338
	Bernadette Yuhas (214) 655-6775	LA	Bill Molere, Permits Programs Manager (504) 342-4685
	Jim Sales (214) 655-6719	AR	Mike Bates, Hz. Waste Division (501) 562-7444
	Mark Sides (214) 655-6719		
VII	Bob Stewart	MO	Frank Dolan, Permitting Div. (314) 751-3176
		KS	John Mitchell, Permitting (913) 296-1608
		IA	Luetta Flournoy, Section Chief
VIII	Larry Wapensky (303) 293-2782	UT	Dennis Downs (801) 538-6170
	Lisa Reed (303) 293-1840	CO	Joan Sowinski, Section Chief (303) 331-4930
		MT	Dwayne Robertson (406) 444-2821
		ND	Martin Shock, Hz. Waste Div. Manager (701) 538-6170
		SD	Joel Smith, Engineer (605) 773-7153
		WY	Dave Finley (307) 777-7752

RCRA Ecorisk Regional and State Contacts (Continued)

Region	Contact		State Contact
IX	Karen Schwinn	CA	Mary Misemer, Enforcement, (916) 322-8046 State HQ
			Jan Smith, Permitting, (916) 324-2423 State HQ
			Steve Baxter, Duty Officer, (213) 620-2380 LA Regional Office
			Nestor Acedera, Assessment & (213) 620-5052 Mitigation, LA Regional Office
		AZ	Al Roesler, Permitting (602) 257-2259
X	Ken Feigner (206) 442-2782	ID	Cheryl Koshuta (208) 334-5876
		OR	Jane Witworth (503) 229-6434
		WA	Hugh O'Neill, Environmental (206) 459-6434 Engineer
		AK	Stan Hungerford, Solid/Hz. (907) 465-2666 Waste Div. Branch Chief

STATE INTERVIEW SUMMARIES

REGION I

Maine -- Andy Cobb

- May have information available for a number of sites, but Mr. Cobb is unfamiliar with this area of inquiry and needs time to check into files and ask his coworkers about specific sites, document availability, and ecorisk issues. He may contact us with more information.

Massachusetts -- Jeff Chorman and Ralph Fine

- Identified two sites with possible ecological considerations involved in RCRA permitting and corrective action:
    - Wyman-Gordon, North Grafton, MA: facility in post-closure permitting has been studied with regard to effects on a nearby wetland and incorporation of ecological effects in the ACL process;
    - GE Pittsfield: facility is allegedly responsible for PCBs in the Housatonic River.
- Documentation for the Wyman-Gordon facility may be available through Region I. John Zipeto of Region I has sent a copy of Chapter 11 of the RCRA Part B Permit Application that was used by the Hazardous Waste/Groundwater Task Force.
- Non-site-specific studies of ecological threats include work in Boston Harbor and New Bedford Harbor. The relationship between these studies and RCRA is not clearly defined.
- Although Mr. Chorman is aware of a number of large utility generation stations in Massachusetts, he could remember no studies of the ecological impacts of their waste management practices.
- Ecological assessment methods used include:
    - Wetlands assessment including species counts, plant density and height, leaf counts, and measurements of Arsenic uptake;
    - Use of aquatic life water quality criteria to determine acceptable ACLs;
    - "Microtox" work in surface waters by the Division of Water Pollution Control.

- Information about ecological threats is used to decide upon appropriate cleanup and action environmental concentrations and cleanup methods. Incorporation of ecological considerations in ACL petitions and review is new; its effects on the ACL decision process are as yet uncertain.

REGION II

New Jersey -- Bill Sharples

- Identified no sites with known or suspected ecological threats.
- Suggested that we obtain copies of some facility "Health and Environmental Impact Assessments" to review for their incorporation of ecological threat information. Mr. Sharples also mentioned site evaluations and siting commission work as possible sources of relevant information. (A letter requesting copies of some of these documents has been sent to Ernie Kuhlwein, Section Chief, Division of Hazardous Waste Engineering.)
- The Hazardous Waste Division contacted the Division of Water Resources and the Department of Fish and Game to identify potential effects of RCRA facilities on ground water, surface water, trout streams, and wetlands.
- Siting commission selects potential facility sites using location criteria which may include ecological considerations.
- Mr. Sharples was aware of no measurements of effects of hazardous releases from RCRA facilities in the half of New Jersey for which he is responsible.
- Vegetation damage has been observed at a few sites, but this information has not led to a more thorough study of the ecological effects, merely to indicate potential releases for further study.

New York -- Steve Cominsky

- Identified the Ciba-Geigy Main Plant as an exemplary case of the incorporation of ecological threat studies and information in RCRA. However, negotiations concerning plans for required ecological studies in the Hudson River and another area adjacent to the plant are just getting underway between the State and Ciba-Geigy; no information is yet available.

- No documentation is yet available, although Ciba-Geigy has apparently proposed some type of ecological assessment in the river and adjacent area. A negotiated agreement on the proposed study will be included in a modified permit for the facility.
- Non-site-specific studies include river contamination studies of the Hudson River and Grass-St. Lawrence Rivers. These studies may not relate directly to RCRA.
- Methods used to assess ecological impacts include investigations (specifics not clear) of fish in the river studies and body burden in wildlife.
- Ecological threat information will be used in determining corrective action requirements.
- A major problem in incorporating ecological threat information in New York state's RCRA program is its regulatory limitation to onsite investigations. Presently, New York must defer offsite investigations to EPA or work out specific state orders to permit such investigations on a site by site basis.
- Referred to Mr. Ward Stone, 518-439-8017, of the New York Division of Fish and Wildlife. Mr. Stone has assisted in developing study requirements for the Ciba-Geigy facility and is often called in to supply expertise on ecological study methods and potential ecological impacts.

REGION III

Delaware -- Wayne Thomas

- Agreed that the Texaco Oil Seep Area may provide good ecological impact information. We have sent him a letter requesting documentation of this area.

REGION IV

Alabama -- Buddy Cox

- Chem Waste Management Site: currently gathering data on benthic organisms in a stream adjacent to the site to assess a potential ecological threat. Many variables effecting the stream's ecosystem - it is difficult to determine how much RCRA contaminants have contributed to damage at the impacted stream.

- ILCO site: the State has identified a dead stream reach downstream from this site. Mitigation is proceeding on corrective action impart based on biomonitoring data which has been used to quantify the ecological impact.
- The State is sending information on the sites mentioned above.
- Problems are foreseen with risk based threshold levels, Mr.Cox is not confident that the human health risk levels will be protective of the environment. He would like to see ground-water monitoring required even when sites are considered to pose no threat to human health.
- The State does not have a toxicologist to interpret ecological risk.

South Carolina -- Hartsill Truesdale

- A hazardous waste landfill poses a potential ecological threat to a recreational lake adjacent to the site. The potential threat is monitored with macroinvertebrate biomonitoring and fish bioassays. Mr. Truesdale suggested contacting Russ Sherer for more information on the biomonitoring program (Division Director of solid and hazardous waste Burro (803) 734-5296).

Kentucky -- Muhammad Alauddin

- Safety Clean Corp in Ashland, KY: ground-water contamination poses a potential threat to surface water - at present State is not conducting any biomonitoring or bioasssays.
- A written request for information of additional sites was sent August 10, 1988.

Mississippi -- Sam Maberry

- Information was provided on three Wood Treatment facilities:

  The first example Mr. Maberry talked about was a SWMU's closure. Fish kills have occurred in an adjacent surface water body. PCP and dioxin detected in surface water samples and fish tissue analysis have been linked to the wood treatment facility. However, it is difficult to assess which pathway is having the largest impact on surface water -- the ground-water to surface water pathway or the runoff to surface water pathway. The State has focused its attention on the threat to aquatic life rather than human health because threshold values for PCP are lower for aquatic life than human health. The State's goal is to set soil concentration limits which will ensure that contaminant concentrations reaching the surface water body through ground-water loading will not pose a threat to aquatic life. At present, the State has nc means to predict the fate and transport of the PCP and dioxin in the contaminated soil.

- At the second site, surface water has been contaminated from a RCRA facility and a potencial ecological threat exist. An RFA conducted at the site identifies ground-water to surface water as a potential pathway. However, the RFA focused on human health risk. Because PCP is a greater threat to aquatic life than human health, the State would like to focus on the potential threat to aquatic life. The problems and needs associated with this site are synonymous with the first example discussed above.

- At the third site, ground-water monitoring has identified PCP concentrations in excess of Clean Water Act standards. The State will attempt to tie this information into the SWMUs closure requirements.

- Texas Eastern Gas Pipeline Compression Station: PCB contamination is documented at this site. Terrestrial and aquatic animal tissue analysis has reveled PCB bioaccumulation. Corrective action has been initiated at the site. The company is required to undertake a risk assessment, however, the risk assessment will focus on human health only, because no guidelines exists for ecological risk assessment.

REGION V

Indiana -- John Hayworth

- One site: Four County Landfill
  - Believes that many other sites are likely posing ecological threats, though is less certain about existence or availability of documentation;
  - NFWS did a study on the Four County Landfill site; draft report was produced winter 1988 with ATSDR; major citizen outcry regarding site and many litigations ensuing; have not yet been able to obtain documentation from NFWS.

- A Biological Studies Group has existed in the State office for about 20 years - work has focused primarily around the water program (i.e., identification of stream discharges & effects -- not necessarily RCRA). Contact person for this group is Lee Bridges (Chief, Biostandards Section (317) 243-5030); have not reached him to discuss available documentation.

- No standard methodology has been established to examine ecorisks resulting from RCRA facilities. Few or no studies have been done examining land-based ecological threat analysis or risk assessment -- "easier to study a stream environment."

- Money has not been designated for analyzing ecological aspects of risk assessment -- risk potential is often observed/identified during site investigations, but "not going the next step (to evaluate and attempt to quantify threats)."

Ohio -- Mike Savage

- Didn't know of any sites offhand. A letter was faxed to Mr. Savage (8/1) at his request outlining information we need; he plans to distribute it to appropriate staff, send any relevant documentation, including at least one sample RFI or incident-response.

  No standardized assessment criteria have yet been established for RCRA permitting, closure or inspection activities.

- Ecorisk has little to no role in RCRA decision-making.
- Recommended contacting the Division of Water Quality Management - they do some stream surveys, bioassays, monitoring. DWQM is not exclusively RCRA.

REGION VI

Louisiana -- Bill Molere

- One facility: an incinerator (name unknown) for which an environmental risk assessment is being considered -- expected to involve dispersion modeling and fugitive emissions effects on nearby human health and wildlife.
- No general or site-specific documentation available. There has been very little emphasis on ecorisk since most of the facilities requesting permits have been existing facilities, and thus the permitting staff has assumed that any species that have been coexisting with the facility until that point will continue to do so. Apparently, if they were permitting a new facility, the facility would be forced to pay more attention to the surrounding areas and wildlife habitats -- new permitting standards will be "more stringent in all respects."
- Unaware of any information contained in the RFAs and RFIs completed to date that would discuss ecorisk since no ecological assessments have been deemed necessary.
- Recommends that we speak with Water Quality people - doing NPDES assessments. (Water Pollution Control Division (504) 295-8904, Bruce Hammond - may have reports covering response activities for spills to surface waters).

Oklahoma -- Robert Rabitane (Environmental Program Administrator)

- No known or suspected incidences of ecorisk resulting from RCRA facilities.

- Although he's heard "rumblings" about evaluating ecorisks from the NPDES work groups, ecorisks have not really been an issue. Documentation is therefore virtually nonexistent.

- Is aware of dangers with ecological threats and the effects of hazardous constituents on wildlife habitats, etc.., but sees ecorisk assessment as more of a wave of the future -- bioassays may soon be more common, but now nothing is done.

- Recommended some other Regional contacts: Karen Bond (Project Officer for the State RCRA program); Lorie Burch (Permitting in Oklahoma).

REGION VII

Missouri -- Frank Dolan

- Schuykill Metals Corporation -- old releases from wastewater treatment to a creek (primarily lead); also associated air releases.

- Was reluctant to discuss site-specific or general ecorisk issues before confirming our right to the information (e.g. requested contract codes, project officers, etc.); was subsequently unavailable for an interview.

Kansas -- John Mitchell

- Ecological risks are not emphasized. Identified no known sites or studies.

- Feels that there is groundwater contamination to streams, but no studies or assessments have been done or planned.

- Any assessments from contaminant releases would be human health-based.

REGION VIII

North Dakota -- Martin Shock

- Degradation of ground water has been identified at a Gas Refinery in Wiliston, ND. The site has under gone SWMU's closure and corrective action has been implemented to clean up the contaminated ground water. The ground water is hydrological connected to a surface water body and the contaminated plume poses a potential ecological threat. However, at present the contaminant plume has been contained and contaminant loading to the surface water body has not occurred. Cleanup target levels are currently set at background concentrations. Mr. Shock does not believe that the new corrective action regulations will affect this site (new Subpart F regulations will set target levels based on human health risk). North Dakota has a strict Ground-Water Protection Law that does not permit any ground-water degradation. This ground-water protection law will continue to require cleanup to back ground concentrations even if Subpart F does not.

South Dakota -- Joel Smith

- Identified no RCRA sites with known ecological threats. However, he suspects contaminants released from RCRA sites may have contributed to ecological damage (i.e., degradation of surface water), but any RCRA contaminant impact would generally be over shadowed by the impact of surface water discharges.

Colorado -- Joan Sowinski

- Identified two sites with potential ecological threats:
    - Martin Marietta
    - Rocky Flats
- Both ground water and air contamination have been identified. A Draft permit has been prepared for both sites. For additional information Ms. Sowinski suggested contacting Greg Strakevum (303-331-4845).

REGION IX

California -- Jan Smith, Mary Misemer, and Steve Baxter

- Two facilities:
  - BKK Landfill (Southern Cal., GW Contamination)
  - Stringfellow (Entire unit of State office formed as a result of this site)

  (Interviewees were unsure of the extent of environmental or habitat degradation at these sites, but thought that environmental impacts assessments had been done. They also felt confident that there were other sites of which they were unaware);

- Site specific information is likely available from the Assessment and Mitigation Units of the four regional offices within the State. According to the Duty Officer in the Los Angeles regional office, any file retrieval or other assistance in obtaining or sending documentation would be a low priority task, and "would take many weeks."

- RCRA site inspections include observations of vegetation and nearby animals, groundwater sampling, and occasional bioassays.

- Ecological risks likely regulated primarily under California Environmental Quality Act (CEQA). We received a pamphlet describing CEQA.

- Attention is given to ecological threats under CEQA; interviewee felt that ecorisks were adequately addressed, and not neglected with respect to human health risks.

- Recommended additional contacts:

  Nestor Acedera - Unit Chief, Assessment and Mitigation Unit, Los Angeles EPA office (Region 3 of California) (213) 620-2380;

  Jenny Lewis - Stringfellow Unit (916) 323-2978.

- For other specific site info - recommended speaking with the Technical Services Unit of Surveillance and Enforcement within each of the four Regional offices in the state:

1	Sacramento:	(916) 739-3374
2	Emoryville:	(415) 540-3347
3	Los Angeles:	(213) 620-2380
4	Long Beach:	(213) 590-5907

REGION X

Alaska -- Sam Hungerford

- Ground-water contamination has occurred at two oil refineries - cleanup to background concentration is authorized by the State Oil Spill program.
- Air emissions from an ammonia plant pose a potential ecological threat. Vegetation stress is suspected, however, there has been no attempt to provide any quantitative proof.
- The State of Alaska is now in the process of adopting regulations for Siting Hazardous Waste Facilities. The regulations will include criteria specifically aimed at protecting the environment. These measurements include protection of sensitive environments (e.g., critical habitat, National Wildlife refuge and wild and scenic rivers), and an analysis of the impact of expected maximum emission from the facility on fish, wildlife, water, visibility, vegetation and soils.

Washington -- Hugh O'Neill

- The State makes use of a fish bioassay to predict potential ecological impacts from hazardous constituents. Mr. O'Neill is sending the fish bioassay protocol and a list of sites where fish bioassay data has been used in regulatory decisions.
- Fish delays (spawning salmon) have been observed in a stream adjacent to a RCRA facility. The State believes that the salmon may be avoiding a polluted area. The site is presently under investigation.

EPA REGIONAL INTERVIEW SUMMARIES

Region I -- George Furst, John Zipeto, Matt Hoaglund, Larry Brill, David Lim

- Identified GE Pittsfield as a site with ecological impacts addressed in RCRA. Facility is allegedly responsibly for PCBs in the Housatonic River. Another possible site is a facility in Maine (possibly Pioneer Plastics) at which a bioassay with plant species has been conducted.

- Documentation for GE Pittsfield is in the Region, but it makes a three to four foot long stack. The site is still in the data collection stage of an ongoing enforcement action, with corrective action-type permitting in process. Part of the information is in the RFI.

- Identified Portsmouth Naval Shipyard as a site where ecological and/or biological monitoring may be required for permit application.

- Region I has 8 to 10 RFI's underway -- none are completed other than a draft report from a Monsanto site (contains no ecological threat information).

- A model corrective action order has been obtained from Mr. Furst. This order was developed for the Saco Defense Inc. site in Saco, Maine. Mr. Furst acknowledges that very scant attention is given to ecological threats in the order. He would appreciate receiving comments on how ecological threat information might be better addressed in the order.

- Methods used to assess ecological threats include a plant species bioassay and environmental assessment (similar to an endangerment assessment).

- A major barrier to incorporating ecological threat information into RCRA decision making is the lack of adequate guidance in corrective action on this issue.

- Non-site specific efforts related to ecorisk include:

    - Ecological Risk Work Group Issue Papers on RCRA, CERCLA, and municipal and industrial landfills. The group uses a variation of the National Comparative Risk method - will not rank threats to various ecosystems. Copies of draft papers obtained from Larry Brill, Region I.

    - Region X Comparative Risk Project Ecological Damages Plan of Attack for Problems 13 through 17. Copy obtained from David Lim, Region I.

    - ICF Incorporated Comparative Risk Project Ecological Risk Assessment Methodologies.

- Limited efforts to manage ecological risks have included an attempt to prioritize the problems in each ecosystem within the Region to determine the relative effects of RCRA waste sites on the Region's ecosystems.

Region II -- Ellen Doring and Barry Tornick

- Identified two sites with ecological threat studies and information:
    - Union Carbide facility in the Caribbean: discharge to a bay is potentially affecting endangered species;
    - GE facility in Waterford, New York: ACL petition.
- Non-site-specific studies include the monitoring of fish in the Lower Hudson for an EIS of a proposal to landfill dredged sediments. The relevance of this study to the RCRA portion of this action (permitting the landfill) is uncertain.
- Methods used to assess ecological threats include studies of body burdens in fish (and fish community structure?), use of ACL and other criteria in Subpart F and proposed Subpart S to protect aquatic life, and bioassays of species related to endangered species.
- A barrier to the use of ecological threat information in RCRA is the infancy of the corrective action program. Not much data is available yet.
- Suggested contacts: Marian Olson, Region II, Office of Policy and Management. Works on risk assessment policy issues. 212-264-5682.

  John Gorman, Region II, Project Manager for the Caribbean facility. 212-264-9631.

Region III -- Jim Webb, Jack Potosanak, and Diane Schott

- Referred by John Humphries, Region III RCRA Section Chief, for information regarding Aberdeen Proving Grounds. Identified three areas of the Proving Grounds of potential interest to this project:
    - White Phosphorus Dump Zone
    - Canal Creek
    - O Field
- We sent a letter to John Humphries requesting documentation regarding ecological studies and threats at these three areas.
- Ms. Schott suggested investigating reports on the tar pit area, which is seeping into a wetland, of the Texaco land treatment facility. Contact is Wayne Thomas, State of Delaware, 302-736-3824.

- Another potential site of interest is an Allentown, PA underground storage tank release site.

- No standard methods are used to characterize ecological threats. Ecorisk assessment effort has been limited. Site-specific assessments are conducted at the discretion of individual permit writers. No standard procedure or policy is in place to assess ecological threats at all sites.

- Special ecorisk-related efforts in the Region include the Regional Superfund Work Group.

Region IV -- Mickey Hartnett

- Identified four sites of potential interest:
    - Plat Whit Corp, United Technology Division, West Palm Beach, FL
    - Kennedy Space Center, FL
    - wood treatment facility (interviewee did not recall the name at time of interview)
    - chemical plant, GA (possible Union Carbide)

- Methods used to characterize ecological risk include:
    - Proximity to important/sensitive area
    - Key-species Biomonitoring (Adapted from a Water Program Toxicity Test used for NPDES)
    - Fish Kill (example: widespread damage to river oyster beds)
    - Bioaccumulation in fish and wildlife (emphasis is placed on the potential danger to human health from the consumption of contaminated fish/wildlife)

- These methods are inadequate. Regional staff are looking for guidance on how to assess ecological threat/damage.

- Ecorisk management in the Region has generally been restricted to the ACL process. In several instances ACLs were denied on the basis that proposed contaminant levels were potentially harmful to aquatic life.

- Regional needs associated with ecorisk management include guidance in determining how to establish aquatic protection levels.

- Special efforts in the Region include an adaptation of a Water Program Toxicity Test (a key-species biomonitor test used for NPDES discharge assessment) to assess potential ecological threat to surface waters.

Region V -- Joe Boyle and Jim Brossman

- Identified two sites of potential interest:
  - Four County Landfill, Indiana
    Ongoing study determining the need for corrective action. Fish & Wildlife Service currently looking into site-related ecological threats. Interviewee unsure if any documentation exists yet.
  - Another site mentioned (name unknown) in southern Illinois - involved extensive lead contamination and resultant ecological threats at a wetland.
- Documentation of ecological impacts may be contained in permit applications and RFAs that have been completed under the permitting program -- primarily permit-seeking, but also for non-permit-seeking facilities. These may have relevant information, but would depend on permit writer. This documentation is probably available for inspection (appropriate contact for documentation availability is Augusta Bloom @ (312) 886-4186). Would be a "large undertaking" to have documents copied for us.
- A couple of ongoing, non-RCRA site-specific Regional studies "may include a discussion of ecological threats":
  - Southeast Chicago Air Study
  - Northwest Indiana Grand Calumet River Basin Study

  Interviewee thought these were probably general studies, not solely RCRA-oriented, and designed to cover a variety of stressors for certain geographic areas. Some preliminary documentation/results may exist, but interviewee wasn't sure how to obtain copies.
- Methods used to characterize ecological threats include:
  - Toxicity testing of exposed species
  - Interpolation from human health assessments

  No standardized method has yet been established
- Interviewees think these methods and the effort committed to ecorisk characterization are inadequate. Permitting process and RFAs "designed with no thought to ecological effects - problem essentially being overlooked." At one site, the interviewee (Janis Perino, Illinois) stated that the ecological effects were "too big to deal with" (involved lead contamination at a wetland). Technology exists to conduct far better studies at each site than current and previous efforts have allowed.
- Ecorisk management may have entered corrective measures selection. Ecological threats were "probably considered" during the selection

process of corrective action remedial alternatives. Interviewees did not mention any specific barriers to the use of this information.

- Specific needs for the consideration of ecological threats include:
    - Update terrestrial ecorisk species data to a level comparable to that of the aquatic species data;
    - Develop guidance for community descriptions (habitat studies) to be conducted during site investigations;
    - Determine effects of mixtures of substances with regard to exposure risks;
    - Resolve the "how clean is clean?" issue.
- Identified a State program in Illinois -- Ecotoxicology program set up within Illinois' DEP Office of Chemical Safety (headed by Janis Perino) -- as program in the Region emphasizing ecorisk.

Region VI -- Doug Ablen, Bernadette Yuhas, Jim Sales, Mark Sides, and Maria Daniels

- Identified one site of potential interest: surface impoundment releasing to surface water. Enforcement action precludes release of details.
- A special effort in the Region is the Environmental Priority Initiative -- a system used to prioritize regulatory attention at RCRA facilities. Includes identification of nearby sensitive populations and habitats. Uses information in RFAs (which contain little or no information on ecology and biology).
- Ecological risk not commonly investigated. Wildlife agencies are frequently consulted to determine nearby endangered/threatened species habitat. Vegetative cover is observed during visual site inspection for RFA.
- A barrier to the use ecorisk information is the lack of data collected/presented in RFAs.
- Future efforts should emphasize the consideration of environmental threats as well as human health threats.

Region VII -- Bob Stewart

- Identified two sites of potential interest:
    - International Paper, Joplin, MO
    - NEIS Landfill, Furley, KS

- They rely on the ACL Guidance Document, Corrective Action Guidance, and the 1980 Federal Register notice on AWQC to incorporate ecorisk management into the RCRA program.

- In one instance of testing body burden in fish was used to characterize ecological threats. This information of fish body burden was used to determine ground-water protection strategy.

- The primary barriers to the use of ecorisk information are inadequate knowledge of and inability to measure ecological effects, and the emphasis within RCRA on human health.

- The primary needs for improved ecorisk consideration are better guidance and making ecorisk a higher priority.

Region VIII -- Larry Wapensky and Lisa Reed

- Identified a number of facilities of potential interest:
  - IRECO Chemical
  - Gary Petroleum Refining -- located on the Colorado River near a rare fish habitat.
  - Highway 36 Facility -- an intermittent pond collecting site runoff. Permit specifies that the runoff must not be accessible to wildlife.
  - Moab UT hazardous waste incinerator -- public concerns raised about effects of stack emissions on Colorado River.
  - Tooele County UT hazardous waste incinerator -- public concerns raised about effects of stack emissions on antelope habitat.
  - Other (unknown) site -- permit requires fence around drainage ditch to keep cattle from drinking liquids seeping from site.

- Ecorisk characterization methods include the potential use of bioassays of stream water.

- Ecorisk information may be used to determine permitting requirements.

- The primary barrier to the use of ecorisk information in that the program does not support the use of risk analyses; it is only beginning to incorporate human health risk.

Region IX -- Karen Schwinn

- No sites were identified.

- No ecorisk characterization methods known.

- Interviewee stated that effort and methods applied to ecological assessments have thus far "intuitively been inadequate", though no data were available to support this claim.

Region X -- Ken Feigner

- Identified two facilities of potential interest:
  - Kalama Chemical Plant, WA; and
  - ARCO Oil and Gas Facility, Alaska
- Methods used to characterize ecological risk include aerial photographs to show vegetation damage.
- The primary barriers to the use of ecorisk information in RCRA are the emphasis on the protection of human health, and inadequate guidance to assure protection from ecological risk.
- EPA has initiated litigation for alleged violations at the Kalama Chemical Plant. Aerial photographs showing vegetation stress will be presented as evidence. However, emphasis will be placed on potential threat to human health rather than ecological damage.
- A non-site-specific project of potential interest is the Dredge and Fill Program for the Corp of Engineering. In this program criteria have been developed to assess potential ecological damage from deep water ocean dumping of dredged materials. Contact in the Water Permit Section handling dredge/fill spoil for deep water disposal: Mr. Mochnick, 206-442-4817.

APPENDIX E

DETAILED SUMMARY OF RCRA SUBTITLE C FACILITY CASE STUDIES

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 1

Site Name: Saco Defense, Inc.
Location: Saco, Maine **Region:** 1

Facility/Site Description

- Saco Defense, Inc. operates a weapons manufacturing facility that generates metal degreasing solvent, waste coolants, chrome plating wastes, metal hydroxide sludges, and chrome stripping salts. This facility is comprised of twelve SWMUs including six landfills/lagoons, five waste storage areas, and one wastewater treatment plant.
- No information is available on the uses of neighboring land or the environmental setting of the plant.

RCRA Program Status

- Saco Defense is party to a consent order with EPA Region 1 to conduct an RFI for this facility. The consent order makes clear that significant environmental contamination exists at this facility.
- This Consent Order is used as the model order for Region 1.

Environmental Threats, Observed or Modeled

- Ground water, soil, surface water, and air may potentially be contaminated by 1,1-dichloroethane; 1,2-dichloroethane; 1,1-dichloroethene; 1,1,1-trichloroethane, and methylene chloride..
- Potentially contaminated biota include fish and vegetation.
- Environmental contamination might potentially occur from seepage of hazardous constituents from landfills and lagoons to ground water, overland flow to a surface drainage channel and surface water, discharge to surface water from wastewater treatment facility, and volatilization to the air.
- The areal extent of the potential contamination is not specified.

Ecological Impacts, Observed or Modeled

- No ecological impacts have been identified. The consent order proposes an evaluation of environmental threats to include an identification of nearby wildlife and sensitive areas, and evaluation of indicator chemicals to be used in assessing environmental risks of estimated exposure point concentrations.

Use of Ecological Information

- The proposed use of ecological threat information is not evident in the consent order.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 2

Site Name: Wyman-Gordon
Location: North Grafton, Massachusetts Region: 1

Facility/Site Description

- The waste management area of concern at this facility is a treatment lagoon.
- Ground-water flow from the lagoon area is towards a wetland that flows into a stream.
- Human receptors and a fishery are sufficiently distant that the site presents no significant threat to them.

RCRA Program Status

- Wyman-Gordon has submitted a Part B permit application for this facility. This application includes an alternate concentration limit (ACL) petition.

Environmental Threats, Observed or Modeled

- The wetlands, surface water, and ground water in the vicinity of this site are contaminated with arsenic, chromium, nickel, and high pH.
- Contamination enters the environment by leaching from the lagoon to the ground water, migrating to springs in the wetland, and flowing into the stream. (The presence of elevated levels of arsenic has not been conclusively linked to the lagoon).
- 3.5 acres are contaminated with elevated levels of arsenic; considerably smaller areas are contaminated with nickel and chromium.

Ecological Impacts, Observed or Modeled

- Wetlands areas receiving leachate from the lagoon have been shown to be significantly stressed. A comparative wetlands assessment of an area below the lagoon and one above it demonstrates decreased species diversity, decreased productivity, stunted growth, and altered life-cycles of the wetland vegetation downstream of the lagoon. These effects have been correlated to high pH values in the degraded wetland.
- The stream down gradient of the wetland was determined by a biological assessment to be healthy.

Use of Ecological Information

- Information on the health of the wetlands and stream have been used to demonstrate that releases from the facility are mitigated by the wetland and cause no damage to the stream. Based on this reasoning, ACLs equivalent to the highest recorded contaminant concentrations are proposed in the permit application.
- The wetlands assessment recommends that the pH of the lagoon (and hence its leachate) be lowered to alleviate the seep's effects on the wetlands.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 3

Site Name: Allied Chemical Baltimore Works
Location: Baltimore, Maryland
Region: 3

Facility/Site Description

- Allied Chemical operates this chrome plating facility that stores chrome ore tailings and other wastes meeting D007 listing requirements in indoor waste pile storage units.
- This facility is located in an estuarine environment on the northwest branch of the Patapsco River near Baltimore's inner harbor.

RCRA Program Status

- Region 3 is currently negotiating corrective measure selection and design with the owner/operator. This facility has been investigated in a manner similar to a CERCLA remedial investigation.

Environmental Threats, Observed or Modeled

- Estuarine surface waters and sediments, on-site soil and groundwater are contaminated by chromium. There is the potential for minor air contamination.
- Contaminant releases enter the environment through the discharge of wastewater to the harbor and the use of chromite ore residue as a fill material in and around the harbor area.
- 17.3 acres of surface water are contaminated with chromium above the 50 ug/L chronic effects level.

Ecological Impacts, Observed or Modeled

- No acute effects of the contamination have been observed.
- Blue crab and other benthic invertebrates have increased body burdens of chromium.
- Areas of high chromium concentrations have low species diversity.
- Potential impacts include chronic effects (especially to Neirus virens) of exposure to chromium levels above 50 ug/L, and the bioaccumulation of chromium in predatory fish.

Use of Ecological Information

- The potential biological effects of high body burden of chromium are not discussed.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 4

Site Name: Defense General Supply Center (DGSC)
Location: Chesterfield, Virginia **Region:** 3

Facility/Site Description

- DGSC is a 640 acre storage facility with landfills, open storage areas, a fire training area, and a vehicle maintenance area.
- The surrounding land use is primarily single-family residential with a one-quarter mile wide wooded undeveloped area immediately down gradient from the site. Two creeks border the facility and a number of wetland areas are present southeast of the site along Kingsland Creek.
- Endangered species which may be found on this site include bald eagles, peregrine falcons, red-cockaded woodpeckers, and Delmarva fox squirrels. This site contains a 20-acre fenced area with a herd of five to seven elk and a pond which is stocked primarily with blue gill, large mouth bass, and catfish for recreational fishing.

RCRA Program Status

- Areas of this facility are undergoing CERCLA remedial investigations and some of the waste management areas are operated under RCRA permits.
- DGSC has recently requested a permit modification under HSWA to allow construction of a large waste handling building and is proposing field investigations to include bioassays and ecological assessments of surface waters.

Environmental Threats, Observed or Modeled

- Soil, ground water, and surface water are contaminated by metals (e.g., copper, iron, mercury, and silver), acetone, and chlorinated organics.
- Contamination is primarily the result of spills onto soil with subsequent transport to ground water and surface water. Overland flow may introduce contaminants from the soil directly to surface waters.
- Areal extent of contamination is not specified in the available documents.

Ecological Impacts, Observed or Modeled

- A proposed field investigation will study potential ecological impacts of contaminant releases to the streams and wetlands. This study will evaluate the species diversity and community structure of the wetlands and streams, and measure the toxicity of the surface waters with bioassays.

Use of Ecological Information

- Although not explicitly stated, it is expected that the ecological information collected through the proposed field investigation will be used to assess the need for and extent of corrective measures.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 5

Site Name: Rohm and Haas Bristol Plant
Location: Bristol, Pennsylvania **Region:** 3

Facility/Site Description

- This is a chemical manufacturing plant with four distinct areas: a landfill (contains 4,600 tons of hazardous waste), a manufacturing area, an ammonium sulfate storage area, and a trailer staging area.
- The landfill area includes a wates treatment pond and borders the tidally-influenced Delaware River. The landfill and pond are located in the 100-year floodplain.
- This site encompasses over 120 acres of open woodland and marsh land.

RCRA Program Status

- Undergoing Subpart S corrective action following investigation under CERCLA.

Environmental Threats, Observed or Modeled

- Soils, ground water, surface water, and air are contaminated by bis(2-chloroethyl)ether, heptachlor epoxide, benzene, endosulfan, lindane, 1,1,1-trichloroethane, and trichloroethene.
- Potential release and exposure is by leaching from the landfill to ground water, surface runoff, or direct dumping.
- The areal extent of contamination is not known.

Ecological Impacts, Observed or Modeled

- Ecological investigations are ongoing.

Use of Ecological Information

- Ecological investigations are ongoing.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 6

Site Name: Kennedy Space Center
Location: Kennedy Space Center, Florida **Region:** 4

Facility/Site Description

- Kennedy Space Center operates a container storage facility. Ground-water contamination at this site is being cleaned up by an air stripping operation.
- A proposed air stripper is located within Merritt Island Wildlife Refuge.
- There are no residences within ten miles of the air stripping operation.

RCRA Program Status

- The waste management area of Kennedy Space Center operates under a corrective action order. The proposed air stripping operation at this facility is corrective measure developed as a voluntary corrective measure.

Environmental Threats, Observed or Modeled

- The ground water of the facility is contaminated with volatile organic compounds (VOCs) -- primarily benzene, chlorobenzene, and chloroform.
- The air stripping operation introduces these contaminants to the ambient air of the wildlife refuge.
- Wildlife on the refuge may be exposed to the airborne contaminants.
- The areal extent of the contamination is not specified in the available documentation.

Ecological Impacts, Observed or Modeled

- The potential effects of the air stripping operation on the wildlife of the refuge have not been investigated.
- The potential impacts of ground-water contamination on the wildlife has apparently not been addressed.
- A meeting between EPA, DOI, and Kennedy Space Center personnel was recently held to discuss potential effects of the air stripping on wildlife. No results of this meeting are yet available.

Use of Ecological Information

- No ecological information has been collected.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 7

Site Name: Monroe Auto Equipment Plant
Location: Hartwell, Georgia
Region: 4

Facility/Site Description

- This facility is an auto equipment manufacturing plant producing a variety of automotive parts.
- There is no mention of sensitive areas or endangered species in the vicinity of the facility.
- A pond located one-half mile northwest of the site is designated as a recreational water body (i.e., swimming, fishing, etc.)

RCRA Program Status

- Applied for a RCRA permit to landfill sludge. Undertaking corrective actions, comparable to Subpart S, under the supervision of the State of Georgia.

Environmental Threats, Observed or Modeled

- The soil, ground water, and surface water are contaminated by oil, chlorinated alkanes and alkenes, aromatic hydrocarbons, and cadmium.
- The air of the facility may potentially be contaminated by some of these volatile organic compounds.
- Contamination apparently occurs by leaching and runoff from sludge landfilling operations.
- The areal extent of the contamination is not specified.

Ecological Impacts, Observed or Modeled

- Toxicity criteria are not exceeded for sensitive fish and plant species. Blue gills and fathead minnows are considered not to be affected by contaminant concentrations detected. Contaminant concentrations are also believed to be too low to affect plant species.
- No degradation of the biota was observed.

Use of Ecological Information

- Ecological impacts were deemed insignificant, consequently no additional remedial action was undertaken.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 8

Site Name: Pratt and Whitney (United Technologies Corporation)
Location: West Palm Beach, Florida **Region:** 4

Facility/Site Description

- This 7000-acre facility contains one landfill, four burn pits, a recycling center, two waste piles, three incinerators, and many other storage areas and waste treatment units.
- No information on the environmental setting of this facility is available in the available documentation.

RCRA Program Status

- This facility is the subject of a corrective action consent agreement. A workplan for conducting an RFA has been submitted and deficiencies in the facility's Part B permit application have been outlined.

Environmental Threats, Observed or Modeled

- The soils and canal sediments of this site are contaminated with PCBs, solvents, acid wastes, heavy metals, and VOCs. PCB concentrations between 50 and 500 ppm have been observed.
- The air, surface water, and groundwater of this site may be contaminated by these contaminants as well.
- Contamination has resulted from spills, leaks, leaching, exhaust, discharge, and dumping.

Ecological Impacts, Observed or Modeled

- No ecological impacts have been investigated.

Use of Ecological Information

- No information available.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 9

Site Name: Southern Dye Company (SODYECO)
Location: North Carolina **Region:** 4

Facility/Site Description

- Chemical manufacturing plant with unknown waste management operations.
- The ground water below the site is hydrologically connected to the Catawba River.

RCRA Program Status

- This facility has petitioned for alternate concentration limits (ACLs) for environmental concentrations of contaminants released from the facility.

Environmental Threats, Observed or Modeled

- The ground water and surface water are contaminated with metals, chlorinated organics, aromatic hydrocarbons, and pesticides.
- Contamination occurs through seepage to ground water and subsequent ground water discharge to surface water of Catawba River.
- Areal extent of the contamination is not specified.

Ecological Impacts, Observed or Modeled

- Catfish are contaminated but have only low body burdens of pollutants.
- Observed contamination of environmental media is above background, but below threshold criteria.
- There have been no investigations of ecosystem effects of the contamination or the studies of the toxicity of the surface water. Surface water toxicity may be important if pollutant effects are additive.

Use of Ecological Information

- Proposed ACLs of 23 of 52 hazardous constituents are based on aquatic life criteria or fish toxicity test results.
- ACLs denied on basis of improper hydrogeologic characterization.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 10

Site Name: Southern Wood Piedmont Company
Location: Baldwin, Florida **Region:** 4

Facility/Site Description

- This facility is a wood treatment plant that discharges boiler blowdown, water softener backwash, and contaminated storm water runoff from an NPDES outfall. The site also contains waste handling pits that have been dewatered and lined with plastic prior to the replacement of the sludge and covering with a clay cap. The facility is adjacent to a tributary of Baldwin Bay that contains a wetlands area.

RCRA Program Status

- This facility is proposing to determine alternate concentration limits (ACLs) based on toxicity testing results.

Environmental Threats, Observed or Modeled

- The ground water, surface water, and sediments of this site are contaminated with arsenic, chromium, and a variety of aromatic contaminants including phenol, cresols, toluene, pentachlorophenol, tetrachlorophenol, trichlorophenols, and other substituted phenols and cresols.
- Contamination is the result of seepage from waste management pits to ground water and subsequent migration to surface water and downstream sediments.
- Areal extent of the contamination is not known.

Ecological Impacts, Observed or Modeled

- The toxicity of environmental media (ground water and sediments) is being investigated. Preliminary results indicate that media down gradient from the site are somewhat toxic, but ground water from a control well up gradient from the waste management area was found to be the most toxic.

Use of Ecological Information

- The bioassay information collected is intended to assist in the determination of ACLs and action levels for releases from SWMUs under a HSWA permit.
- The higher toxicity of ground water from the control well greatly complicates this procedure.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 11

Site Name: Union Carbide Agricultural Products Company, Inc. (UCAPC)
Location: Woodbine, Georgia **Region:** 4

Facility/Site Description

- UCAPC is a chemical formulation and manufacturing plant containing a 20-acre landfill. This landfill consists of two rectangular sites generally less than fifteen feet deep.
- The facility is located at an elevation of between 5 and 29 feet above MSL along the terraced coastline of Georgia.
- Ground-water flow from the site is to the tidally influenced, brackish Todd Creek. Although this creek borders the site, there is no apparent direct discharge to the creek.
- Todd Creek is a tributary of the Satilla River within the St. Andrew's Estuary. The estuary contains potential receptors such as shrimp, crab, oysters, fish, and aquatic and wetland vegetation.

RCRA Program Status

- Union Carbide has petitioned for and been denied alternate concentration limits (ACLs) for contamination at the facility's compliance point. The State of Georgia has decided not to consider any discharge of toxic contaminants until such time as all environmental stressors in the area have been identified.

Environmental Threats, Observed or Modeled

- The ground water, soil and surface waters of this site are contaminated with metals, chlorinated organics, aromatics, and pesticides.
- These contaminants enter the environment after leaching from the landfill to the ground water and soil, migrating with the ground water approximately 200 feet to Todd Creek, and dispersing throughout the estuary.
- Biological receptors may be exposed to the contaminants by burrowing into contaminated soil, dermal contact and ingestion with contaminated sediments, and immersion in the contaminated surface waters.
- Areal extent of contamination has not been determined; the distance from the site to the mouth of the estuary is approximately four miles.

Ecological Impacts, Observed or Modeled

- 100 percent oyster mortality has been observed in the estuary in the vicinity of the site (this mortality is not conclusively associated with the site).
- Potential exposure of gopher tortoises (protected), indigo snakes (protected), 29 species of fish, seven species of crab, three species of gastropod, four species of bivalve, and four species of shrimp may cause acute and chronic effects.

Use of Ecological Information

- Ecological information provided the primary impetus for the denial of the ACL petition submitted for the facility. Georgia's Environmental Protection Division has stated that adequate demonstration has not been made that proposed ACLs would be protective of larval and juvenile crustaceans and fin fish or non-motile organisms such as oysters and clams.
- Detection limits for ten of the 22 hazardous constituents exceed the proposed ACLs making verification impossible and complicating the use of ecologically protective environmental concentrations.
- The contribution of other sources in the area relative to the landfill needs to be evaluated.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 12

Site Name: Koppers Company, Inc.
Location: Superior, Wisconsin
Region: 5

Facility/Site Description

- This is a 112-acre wood treating facility. This facility contains a spray irrigation field for disposal of treated wastewater, surface impoundments, settling ponds, and a drum storage area. The facility also stores treated and untreated wood products.

RCRA Program Status

- An RFA has been completed at this facility. The RFA recommends certain areas or SWMUs to be more closely inspected during an RFI.

Environmental Threats, Observed or Modeled

- On site and nearby off site soils are contaminated from wood treating operations.
- Two outfalls (treated wastewater discharge points) that drain to a creek are also contaminated.
- Areal extent of contamination not specified.

Ecological Impacts, Observed or Modeled

- One area of "very sparse vegetation" has been observed, otherwise the RFA does not indicate potential ecological impacts.

Use of Ecological Information

- No information available.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 13

Site Name: International Paper Company Treated Wood Products Plant
Location: Joplin, Missouri
Region: 7

Facility/Site Description

- This is a wood treatment facility with waste management areas including ponds, surface impoundments, and landfills.
- Silver Creek, near the facility, receives ground water from below the site.

RCRA Program Status

- International Paper has submitted proposed alternate concentration limits (ACLs) for site-related hazardous constituents migrating off site.

Environmental Threats, Observed or Modeled

- The ground water under the site and the surface water of Silver Creek may be contaminated with creosote compounds and inorganics such as barium, beryllium, nickel, copper, vanadium, and zinc.
- These contaminants may enter the environment by leaching from the waste management areas to the ground water where they migrate to the surface water.
- No information on the areal extent of the contamination is available.

Ecological Impacts, Observed or Modeled

- Potential ecological impacts are not specified for exposures at the site.

Use of Ecological Information

- Acceptable exposure levels and alternative concentration limits for four contaminants are based on criteria protective of aquatic life.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 14

Site Name: National Industrial Environmental Services (NIES)
Location: Furley, Kansas
Region: 7

Facility/Site Description

- NIES operates this 80-acre site as a hazardous waste treatment and disposal facility. Waste management areas at the facility include treatment ponds, evaporation ponds, and land disposal cells.
- The sparsely populated area surrounding the facility consists primarily of farmland interspersed with oil wells.
- Prairie Creek flows through NIES land north of the facility boundary. A small intermittent drainage channel comes within 1000 feet of the northeast corner of the facility. There are several ponds near the facility's eastern boundary.
- Ground water in one of two distinct water bearing zones below the facility flows to springs of Prairie Creek.

RCRA Program Status

- NIES has entered into a consent agreement and consent order under RCRA and a consent order under CERCLA. In this agreement NIES is required to establish alternate concentration limits (ACLs) for certain ground-water constituents.

Environmental Threats, Observed or Modeled

- The surface water and ground water in the vicinity of the site are contaminated with volatile organic compounds (VOCs), beryllium, chromium (VI), phthalates, cadmium, and mercury.
- Contamination enters the environment by leaching to ground water, flowing along solution pathways to the spring, and entering Prairie Creek.
- The areal extent of the contamination is not specified.

Ecological Impacts, Observed or Modeled

- Fish in Prairie Creek are contaminated. Bioconcentration of DDE, chlordane, cadmium, mercury, and VOCs has been observed.
- No stress of macroinvertebrates is apparent and the fish appear to be in good health.
- Threshold criteria protective of aquatic life are not exceeded in the stream.

Use of Ecological Information

- ACLs for seventeen of 35 hazardous constituents are based on aquatic life protection criteria.
- Although no actual/expected receptors are present at the exposure point, conservatism requires the assumption of their presence.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 15

Site Name: IRECO Chemicals
Location: Tooele County, Utah **Region:** 8

Facility/Site Description

- IRECO operates this site as an explosives testing and disposal area.
- Detonation occurs in a quarry in a remote, sparsely populated area.
- The quarry and the surrounding area are known breeding and wintering grounds for numerous species of raptors, including golden eagles, great horned owls, prairie falcons, red-tailed hawks, and ferruginous hawks.

RCRA Program Status

- IRECO has submitted an application for a RCRA permit and has signed a compliance order to dispose of explosive wastes at this site by detonation. As a requirement of the compliance order, the U.S. Fish and Wildlife Service has studied the effects of explosive detonation for testing and disposal on the breeding and nesting behavior or raptors and ravens in the vicinity of the site.

Environmental Threats, Observed or Modeled

- No releases of hazardous contaminants have been observed or are expected at this facility. The environmental threat posed by this site is associated with the atmospheric disturbance caused by the detonation.

Ecological Impacts, Observed or Modeled

- The U.S. Fish and Wildlife Service study of raptor and raven behavior indicates that these birds were able to successfully breed, nest, and raise and fledge young in the vicinity of the detonation site. Historical nest sites in the quarry are no longer used, so some displacement of nesting may have occurred, but a number of nests were identified and observed within 1.6 miles of the quarry.
- The U.S. Fish and Wildlife Service has identified the possibility of direct, acute effects (e.g., death and deafening) of small birds and mammals living within the quarry, but these potential effects have not been studied.

Use of Ecological Information

- The ecological information obtained from the study of raptor and raven behavior supports recommendations by the Fish and Wildlife Service to schedule explosive testing and disposal so as to minimize disturbances to the nesting wildlife in the vicinity of the quarry.
- This information might influence the practice of explosive disposal at the site, but, since EPA has no jurisdiction over the testing of explosives, may not prevent disturbances to wildlife by testing practices.

RCRA SUBTITLE C ECORISK FACILITY CASE STUDY NUMBER 16

Site Name: ARCO Prudhoe Bay Unit - Eastern Operating Area
Location: Prudhoe Bay, Alaska **Region:** 10

Facility/Site Description

- ARCO operates this 192-square mile area of the Prudhoe Bay Unit for oil exploration, production, and development. The area contains a number of landfills, surface impoundments, container storage areas, tanks, waste piles, a recycling unit, and incinerators.
- This area is tundra with many small lakes. Much of the surface area is water-saturated during summer. Vegetation in the area includes sedges, grasses, mosses, lichens, and few flowering plants and low shrubs. The vegetative mat is eighteen inches thick and overlays permafrost.

RCRA Program Status

- An RFA has been conducted for this facility. RFIs of drilling fluid reserve pits and some other pits are suggested in the RFA.

Environmental Threats, Observed or Modeled

- The surface water, soil, and tundra vegetation of the area are potentially contaminated by oily debris and drilling muds containing constituents such as arsenic, barium, cadmium, chromium, lead, nickel, benzene, toluene, naphthalene, and fluoranthrene.
- Contamination might arise through direct discharge of pit contents to the tundra surface, road and gravel pad application of waste liquids, and seepage from pits.
- No estimate of the areal extent of the potential contamination is provided.

Ecological Impacts, Observed or Modeled

- Potential ecological impacts include the bioaccumulation of hazardous constituents from permitted and other discharges.

Use of Ecological Information

- No ecological information collected.

APPENDIX F

CONSTITUENTS IDENTIFIED IN RCRA PROGRAM AREAS

Subtitle C Case Studies

Inorganic Constituents

Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Copper
Cyanide
Iron
Lead
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Strontium
Thallium
Vanadium
Zinc

Organic Constituents

1,1'oxybis-2-chloroethane
1,1'oxybis-3-chloropropane
1,1,1-Trichloroethane
1,1,2 Trichlorethane
1,1,2,2-Tetrachloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2-Dichloroethane
1,2-trans-dichloroethene
1,4-dioxane
1H-phenalene
2,2'oxybis-chloropropane
2,3-dimethyl-naphthalene
2,4,5-T
2,4-D
2-ethylnaphthalene
2-methyl naphthalene
Acenaphthene
Acenaphthylene
Acetone
Acetophenone
Acrolein
Acrylonitrile
Aldicarb
Aldrin
Aniline
Benzene
Benzo(a)anthracene
Benzo(a)pyrene
Benzofluoranthenes
Benzoperylenes
BHC
Biphenyl
Bis (2-chlorethyl) ether
Bis-2-chloroisopropyl ether
Bromodichloromethane
Bromomethane

Radionuclides

Subtitle C Case Studies (continued)

Organic Constituents	Organic Constituents	Radionuclides
	Carbazole	
	Carbon tetrachloride	
	Carbon disulfide	
	Chlorethyl ether	
	Chlorobenzene	
	Chloroethane	
	Chloroethene	
	Chloroethoxyethanol	
	Chloroform	
	Chloromethane	
	Chloromethylbutane	
	Chlorophenol	
	Chrysene	
	Cresols	
	DDE	
	Diaminotoluene	
	Dibenzo(a,h)anthracene	
	Dibenzofuran	
	Dichlorobenzenes	
	Dichlorobenzidenes	
	Dichloromethane	
	Dichloropropane	
	Dichloropropene	
	Dieldrin	
	Dimethyl naphthalene	
	Dimethyl phenols	
	Dinitrobenzenes	
	Dinitrocresol	
	Dinitrophenols	
	Endosulfans	
	Endrin	
	Ethylbenzene	
	Flourene	
	Fluoranthene	
	Fluorene	
	Freon	
	Heptachlor epoxide	
	Heptachlor	
	Hexachlorobutadiene	
	Hexachloroethane	
	Hexane	
	Indopyrenes	
	Isophorone	
	Lindane	
	Maleic hydrazine	

Subtitle C Case Studies (continued)

Organic Constituents

Organic Constituents

- Methacrylonitrile
- Methyl naphthalene
- Methyl indene
- Methyl ethyl benzene
- Methyl flourene
- Methyl styrene
- Methyl ethyl ketone
- Methylene chloride
- Methyl phenanthrene
- Methylpropyl benzene
- Methyl pyrene
- Naphthalene
- Nicotinic acid
- Nitrophenols
- Nitrosodiphenylamines
- Nitrosomorpholines
- Oil
- PCBs
- Pentachloroethane
- Pentachlorophenol
- Phenanthrene
- Phenol
- Phenyl naphthalene
- Phthalates
- Propenyl benzene
- Pyrene
- p-benzoquinone
- p-chloroaniline
- p-Chloro-m-cresol
- Styrene
- Tetrachlorobenzene
- Tetrachloroethene
- Tetrachloroethylene
- Tetrachlorophenols
- Tetraethylpyrophosphate
- Tetralin
- Tetramethylbenzene
- Thiourea
- Toluene
- Tribromomethane
- Trichloroethene
- Trichlorofluoromethene
- Trichlorophenols
- Trichloropropane

Radionuclides

Subtitle C Case Studies (continued)

Organic Constituents

Organic Constituents

Vinyl chloride
Xylene

Radionuclides

Subtitle D Case Studies

Inorganic Constituents

Aluminum
Ammonia
Antimony
Barium
Chloride
Iron
Manganese
Nickel
Nitrate
Nitrite
Phosphate
Sodium
Sulfate
Thallium
Zinc

Organic Constituents

1,2-Dichloroethane
1-Butanol
2-Propenol
Acetone
Dichloromethane
Methyl Ethyl Ketone
PhenolRadionuclides

Mining

Inorganic Constituents	Organic Constituents	Radionuclides
Aluminum		
Antimony		
Arsenic		
Barium Chloride		
Barium		
Beryllium		
Cadmium		
Chromium		
Cobalt		
Copper		
Cyanide		
Fluorine		
Gold		
Hexavalent chromium		
Indium		
Iron		
Iron hydroxide		
Lead		
Manganese		
Mercury		
Molybdenum		
Nickel		
Nitrate		
Radium		
Selenium		
Silver		
Sulfate		
Uranium		
Vanadium		
Zinc		

Oil and Gas Constituents

Inorganic Constituents

Aluminum
Antimony
Arsenic
Barium
Benzene
Borite
Boron
Cadmium
Calcium chloride
Calcium
Chloride
Chromimium
Copper
Fluoride
Hydrogen sulfide
Iron
Lead
Lithium
Magnesium
Manganese
Mercury
Methane
Nickel
Potassium
Silicon
Silver
Sodium
Sulfates
Zinc

Organic Constituents

Anthracene
Benzo-pyrene
Biphenyls
Chrysene
Decane
Dodecane
Fluoranthene
Hexadecane
Naphthalenes
Octadecane
Perylene
Pyrene
Tetradecane

Radionuclides

Radium
Strontium

Coal Utility

Inorganic Constituents	Organic Constituents	Radionuclides
Aluminum		
Ammonium		
Arsenic		
Boron		
Cadmium		
Calcium		
Chloride		
Chromium		
Cobalt		
Copper		
Iron		
Lead		
Magnesium		
Manganese		
Mercury		
Molybdenum		
Nickel		
Phosphate		
Phosphorous		
Potassium		
Selenium		
Silicon		
Silver		
Sodium		
Strontium		
Sulfate		
Sulfate		
Sulfite		
TDS (total dissolved solids)		
Thallium		
Titanium		
Vanadium		
Zinc		

Smelting and Refining Constituents

Inorganic Constituents

- Aluminum
- Arsenic
- Barium
- Cadmium
- Copper
- Cryolite
- Cyanide
- Fluoride
- Lead
- Manganese
- Mercury
- Nitrate
- Selenium
- Silver
- Zinc

Organic Constituents

- Tetrachloroethene
- Trichloroethene

Radionuclides